# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

Vol. 65 November, 1955 No. 5


## CONTENTS


DISCOGRAPHY IN EVALUATION OF LUMBAR DISK LESIONS. *Jack Friedman, M.D., and Meyer Z. Goldner, M.D.* 653

PITFALLS OF MYELOGRAPHY. *W. C. MacCarty, Jr., M.D., and F. W. Lane, Jr., M.D.* 663

THE ROENTGENOLOGIC ASPECTS OF CHRONIC ULCERATIVE COLITIS IN CHILDREN. *John R. Hodgson, M.D., and Roger L. J. Kennedy, M.D.* 671

COEXISTENT TUBERCULOSIS AND CARCINOMA OF THE LUNG. *Harry Hauser, M.D., and Norman M. Glazer, M.D.* 680

PLANIGRAPHY IN THE DIFFERENTIAL DIAGNOSIS OF THE PULMONARY NODULE, WITH PARTICULAR REFERENCE TO THE NOTCH SIGN OF MALIGNANCY. *Leo G. Rigler, M.D., and E. Robert Heitzman, M.D.* 692

ISODOSE CURVES FOR SUPERFICIAL THERAPY. *E. Dale Trout, B.S., Sc.D., John P. Kelley, B.S., Arthur C. Lucas, B.S., and Edward J. Furno, B.S.* 703

ROENTGENOLOGIC CHARACTERISTICS OF THE EPIPERICARDIAL FAT PAD, WITH A CASE REPORT. *Joseph R. Nahon, M.D.* 745

MALIGNANT MELANOMA OF THE SMALL INTESTINE. *Michael F. Beirne, M.D.* 749

CARCINOID OF THE STOMACH. *Walter H. Camp, M.D.* 753

COLLATERAL CIRCULATION OF THE EXTERNAL CAROTID ARTERY AND THE INTERNAL CAROTID ARTERY THROUGH THE OPHTHALMIC ARTERY IN CASES OF INTERNAL CAROTID ARTERY THROMBOSIS. REPORT OF FIVE CASES. *Paul M. Lin, M.D., and Michael Scott, M.D.* 755

DENTAL BONE CHANGES OCCURRING IN SICKLE-CELL DISEASES AND ABNORMAL HEMOGLOBIN TRAITS. *Joseph R. Prowler, Ph.B., D.D.S., and Ernest W. Smith, M.D.* 762

THE RADIOMICROGRAPHY OF THE AUTOPSY BRAIN. I. THE NORMAL PATTERN. *Isadore Meschan, M.D., Chalmers S. Pool, M.D., Anderson Nettleship, M.D., Melvin Winer, M.D., and Wolfgang Zeman, M.D.* 770

RADIOACTIVE GOLD FOR THE INTRACAVITARY TREATMENT OF CARCINOMA OF THE CERVIX. *Michel Ter-Pogossian, Ph.D., and Alfred I. Sherman, M.D.* 779

WORK IN PROGRESS: PRACTICAL IMAGE AMPLIFIER TECHNICS; FLUOROSCOPY, CINEFLUOROGRAPHY, SPOT-FILM RADIOGRAPHY, AND USE WITH CLOSED CIRCUIT TELEVISION. *Herbert M. Stauffer, M.D., Morton J. Oppenheimer, M.D., George H. Stewart III, B.S., in E.E., and Archie W. Blackstone, E.E.* 784

EDITORIAL: TEACHING OR ADVERTISING? *Robert P. Barden, M.D.* 785

ANNOUNCEMENTS AND BOOK REVIEWS. 786

ABSTRACTS OF CURRENT LITERATURE. 791

# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA



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PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Vol. 65 NOVEMBER 1955 No. 5

# Discography in Evaluation of Lumbar Disk Lesions[1]

JACK FRIEDMAN, M.D.,[2] and MEYER Z. GOLDNER, M.D.

SINCE LINDBLOM'S original description of discography, considerable interest has been evinced in this procedure as a means of evaluating lesions of the lumbar intervertebral disks. On the basis of extensive anatomic dissection, Lindblom (4) catalogued the character, the frequency, and the pathologic findings in disk lesions in 160 autopsies. As a part of this anatomic investigation he injected red lead into the lumbar disk and was able to study the degree of degeneration, the direction of protrusion of the nucleus, and the presence of rupture within the disk, roentgenographically. In 1948, he first described the clinical application of discography (5). By injecting 35 per cent Perabrodil (Diodrast) as a contrast material directly into the nucleus of the disk, by puncture with a fine, thin needle, he was able to visualize the internal architecture. He described the normal disk, the degree and direction of fissuring, and the appearance of disks which showed variable degrees of degeneration, protrusion, and epidural leak. He demonstrated, also, that in a high percentage of cases the injection of a pathological or offending disk will reproduce the patient's pain. Thus one can determine if the injected disk is the source of the symptoms, or if a disk, even though it be degenerated, is still not producing symptoms. By this method the examiner is afforded a direct knowledge of the pathological condition of a disk, and in a high percentage of cases he can correlate it with the clinical symptoms.

Myelography has been an aid in the localization and determination of disk protrusion. Clinicians, however, evaluating the results of this procedure at surgery, have found that errors occur in its use. Patients with clear-cut symptoms and proved protrusions may have negative myelograms while, as in many other examinations, false positives occasionally occur.

## MATERIAL AND METHOD

It is the purpose of this report to present an analysis and critical review of the findings in 150 cases of back pain seen in the practice of one of the essayists, an orthopedic surgeon (MZG), in which discography was performed. It is essential to emphasize that not all patients with backache in his practice were referred for this examination; nor were all those with backaches thought to be due to disk lesions operated upon. A large group who were treated conservatively were not referred for examination. Others who were

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[2] Deceased.

eventually referred were originally treated conservatively for variable periods, with the hope that spontaneous improvement might result. Many patients were not referred because the backache was not disabling. In some who had clear-cut symptoms and neurological findings which allowed good clinical localization of the offending disk, myelograms or discograms were not considered necessary and, if surgery were indicated, it was sometimes done without these procedures. In another group of patients only myelography was performed; if it demonstrated the lesion and the localization thus determined was thought to explain all the symptoms, discography was not done.

Discography, therefore, was performed only on those patients with long-standing, severe, incapacitating back pain in whom surgical intervention, in an attempt at rehabilitation, was thought necessary and clinical localization or myelography was inadequate. The examination was considered a means of determining preoperatively the location and extent of the disease in problem cases. The history and clinical diagnostic findings were varied; incapacitating low back pain with or without leg referral was common to all.

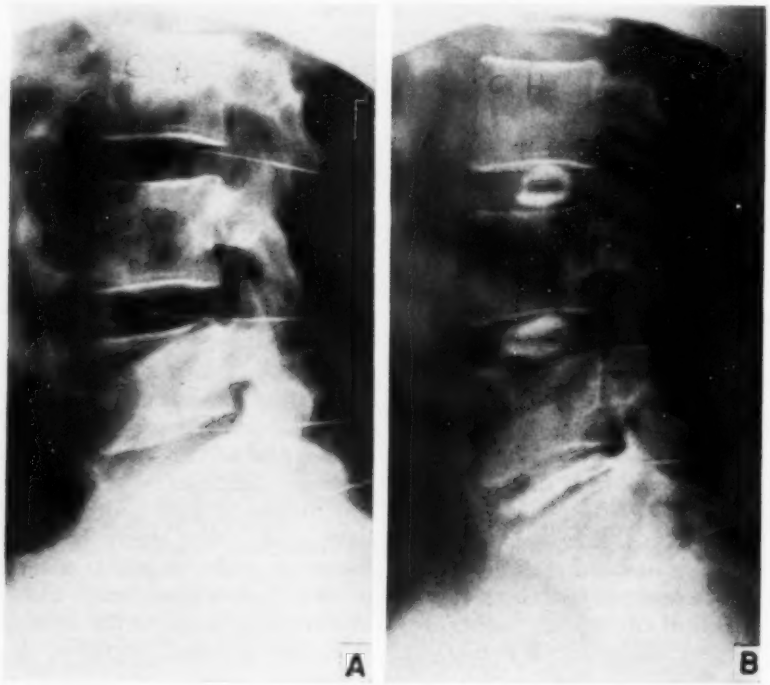


Fig. 1. A. Control lateral film with needles in position in four spaces before injection of contrast medium.
B. Discogram after contrast injection. L2-3 and L3-4 spaces are normal, with no reproduction of pain on injection. L4-5 shows degeneration, marked posterior protrusion, and epidural leak. Injection caused pain in back and down both legs. L5-S1 shows a congenitally narrowed disk in transitional vertebrae, with degeneration. Injection caused pain down the left leg.

Our technic of discography is based upon that of Lindblom, for which the reader is referred to that worker's earlier reports (5–7). Modifications of this technic have been reported by others (1, 2, 3, 8). We feel that the use of fluoroscopy, as described by Lindblom, is most important in assuring proper direction of the fine (No. 26) needle into the disk. This does not mean that the needle is inserted during

fluoroscopic observation. Instead, the fluoroscope is used intermittently to check the position of the needle and the direction of its course. In this manner, excessive probing and unnecessary puncture of the subarachnoid sac are avoided.

### ANALYSIS OF CASE MATERIAL

*Age and Sex:* The series included 75 males and 75 females. The age of the males ranged from seventeen to sixty-six years, with an average of 39.4 years. The range for the females was from twenty to sixty-three years, with an average of 38.5 years.

*Occupation:* Of the 75 males undergoing examination, 62 were laborers and 13 sedentary workers. The 75 females were classified as follows: 30 housewives, 20 office workers, and 25 factory workers, household helpers, or waitresses.

*Status of the Patient:* The evaluation of backache as seen in practice sometimes involves legal considerations and determination of responsibility and damages attributable to trauma. Fifty-one patients in this group (20 males and 31 females) had been referred to the orthopedic surgeon as private patients, with no consideration of litigation. Sixty patients (39 males and 21 females) were referred for treatment under the workmen's compensation act, and 39 (16 males and 23 females) attributed their difficulties to personal injury and were involved in litigation to determine legal responsibility and possible damages.

*History of the Disease:* Thirty-three patients described a gradual onset of symptoms, with intermittent backache becoming progressively more severe over a prolonged period of time. In 117 cases the onset was described as sudden, with or without injury. Fifty-two patients complained of constant unrelenting pain; in 98 pain was inconstant, with more severe and disabling attacks at variable intervals.

*Description of Pain:* Of the 150 patients, 148 complained of backache. Two patients had unilateral leg pain alone and 135 had leg pain associated with backache. Of this latter number, 88 had pain referred to one leg and in 47 the pain was bilateral. Seventeen had back pain alone. Twenty-six patients described an unusual pain pattern, such as radiation to the abdomen, to the inguinal region, or to the perineum. This observation has been made by Lindblom and by others. It has, however, received insufficient emphasis. These cases are deserving of more detailed report, which will be reserved for another publication.

*Duration of Symptoms:* The average duration of symptoms in the male was 2.8 years, with a range of six months to seventeen years. For females the average length of symptoms was 3.4 years, with a range from six months to thirty-seven years.

*Number of Physicians Seen:* From one to nine physicians other than the essayists had seen these patients. The average was two and a half physicians per patient. Numerous chiropractors had performed manipulations and adjustments on members of the group.

*Previous Examinations:* Myelography had been performed previously in 28 cases. One patient had three and a few had two myelograms prior to the examination reported here.

*Previous Surgery:* Two patients had undergone extraspinal surgery in an attempt to obtain relief; 11 patients gave a history of previous spinal surgery, either laminectomy with exploration of the disk or spinal fusion.

*Clinical Diagnostic Findings:* Sensory changes—hypesthesia or paresthesia—were found in 71 cases; 29 showed reflex changes; straight leg raising was observed in 132. Motor weakness was found in only 11 patients, manifesting itself mainly as weakness of the dorsiflexors of the great toe. Interspinous tenderness occurred in 142 of the cases, with the tenderness over one intervertebral space in 55 patients, over two intervertebral spaces in 68 patients, and over three intervertebral spaces in 43 cases. Postural changes—a flattened lumbar curve or scoliosis—were present in 43.

TABLE I: NUMBER OF DISKS INJECTED
(An attempt was made to inject 3 disks in almost all cases.)

| | | | | |
|---|---|---|---|---|
| 150 Cases Had 427 Disks Examined | | | | |
| 3 disks injected in 122 cases. | | | | |
| 2 " " " 21 " | | | | |
| 1 " " " 3 " | | | | |
| 4 " " " 4 " | | | | |
| L2-3 injected in 3 cases | | | | |
| L3-4 " " 133 " | | | | |
| L4-5 " " 146 " | | | | |
| L5-S1 " " 142 " | | | | |
| L6-S1 " " 3 " | | | | |
| Unsuccessful Attempts | | | | |
| L3-4 | | | 3 | cases |
| L4-5 | | | 3 | cases |
| 1 with graft | | | | |
| L5-S1 | | | 8 | cases |
| 1 with graft | | | | |
| 3 with spondylolisthesis | | | | |
| L3-4 was not intended for injection in 14 cases. | | | | |
| L4-5 " " " " " " 1 case. | | | | |

## DISCOGRAPHIC RESULTS

In 150 patients, 427 disks were injected. Our intention in almost all cases was to inject three spaces if possible, in an attempt to determine if this examination could be a complete diagnostic procedure in evaluating the extent of the disease in the presence of limited clinical localizing findings. Table I shows the distribution of the injections. As will be seen, unsuccessful attempts at injection were few, occurring in the L3-4 space 3 times; in the L4-5 space 3 times; and in the L5-S1 in 8 cases. Three of these unsuccessful attempts were in patients with spondylolisthesis and the needle could not be directed into the disk without undue trauma; one patient had a bone graft covering the area, so that a free passage for the needle could not be found. In 4 cases, four disks were injected. This occurred where there was a transitional vertebra between the lumbar and sacral segments; the transitional space was injected with the three disks directly above. In no case was an injection of a space above L2-3 attempted.

Table II summarizes the findings on discography. The appearance of the disk is classified as normal, minimal degeneration without posterior protrusion, more severe degeneration without posterior protrusion, degeneration with posterior protrusion, and degeneration with posterior protrusion and epidural leak. Inasmuch as the elicitation of pain on injection is of importance in incriminating the offending disk, the various pathological categories were further divided on this basis, *i.e.*, with pain and without pain on injection.

If one compares the results of these injections with Lindblom's observations at autopsy, the incidence of degeneration is seen to be strikingly similar. The occurrence of pathological disks and the degree of degeneration increase at the lower disk levels.

The distribution of the offending disks as determined at discography is recorded in Table III. Those cases listed in Table II as showing minimal degeneration were considered non-offending. Cases of more severe degeneration without posterior protrusion were considered offending only if reproduction of significant pain was obtained on injection. All degenerated disks with posterior protrusion were regarded as offending or potentially offending. It is understood that many cases showing severe degeneration without reproduction of pain represented old inveterate degenerations which had undergone spontaneous healing and possibly were not offending at the time of examination. Very critical correlation of this finding with the clinical history should be made.

The number of cases with disk degeneration accompanied by posterior epidural leak was greatest at the L4-5 and the L5-S1 level. At that level there were 5 cases showing severe degeneration and posterior epidural leak in which the pain was not reproduced on injection. The absence of pain in these cases may have been due to the fact that the pressure within the disk could not be increased, as the injected contrast material ran freely from it. In the majority of cases with epidural leak, however, pain was elicited, which would suggest that the sclerosis and an inflammatory process associated with degeneration are a part of the mechanism causing back pain.

It is of interest that only 50 of the 150 patients had a single offending disk space.

TABLE II: DESCRIPTION OF DISK LESIONS ACCORDING TO SPACES, WITH CORRELATION OF PAIN REPRODUCTION TO THE PATHOLOGIC CHANGE

| Disks | | L2-3 | L3-4 | L4-5 | L5-S1 | L6-S1 | Totals | Total |
|---|---|---|---|---|---|---|---|---|
| Normal | With pain | | 0 | 1 | 0 | 0 | 0 | 1 |
| | Without pain | | 2 | 53 | 25 | 6 | 2 | 88 |
| Minimal degeneration without posterior protrusion | With pain | ... | ... | 6 | 6 | 4 | ... | 16 |
| | Without pain | ... | ... | 35 | 16 | 8 | ... | 59 |
| More severe degeneration without posterior protrusion | With pain | ... | ... | 4 | 1 | 2 | ... | 7 |
| | Without pain | ... | ... | 4 | 0 | 2 | ... | 6 |
| Disk degeneration with posterior protrusion | With pain | ... | ... | 17 | 46 | 82 | ... | 145 |
| | Without pain | ... | ... | 4 | 5 | 4 | ... | 13 |
| Disk degeneration with posterior epidural leak | With pain | | 1 | 9 | 46 | 28 | 1 | 85 |
| | Without pain | | 0 | 0 | 0 | 5 | 0 | 5 |
| TOTALS | | | 3 | 133 | 145* | 141* | 3 | 425 |

* Plus 1 surgical defect. No pain.

Ninety-two had multiple offending disks in the following distribution: 66 cases at two levels, 25 at 3 levels; and 1 at four levels that were examined.

The fact that normal findings were so few can be attributed to the selection of patients referred for discography. It should be pointed out that in 4 cases which were completely negative and were involved in litigation, the absence of any demonstrable pathology in the disks was of great value in more accurately evaluating the true extent of organic injury.

It should be stressed that the type of material presented here may not be duplicated in other groups of cases selected differently. A number of our cases were ones in which accurate clinical localization could not be made. In view of the frequency of multiple involvement and the variable degree of pathology, it is easily understood why clinical localization may be inaccurate.

*Comparison of the Myelogram and the Discogram:* In 50 of the 150 cases studied, Pantopaque myelography was also performed. In only 14 of these did the myelogram and discogram agree completely as to negative or positive findings; in 22 cases there was complete disagreement. In the latter group the discogram demonstrated a single offending space in 11 cases that were negative on the myelogram; 8 cases with two offending spaces on the discogram were negative on the myelogram; and in

TABLE III: DISTRIBUTION OF OFFENDING DISKS IN 150 CASES. NOTE THE FREQUENCY OF MULTIPLE DISK INVOLVEMENT

| | | | |
|---|---|---|---|
| L3-4 alone* | 0 | L2-3, L3-4, L4-5, L5-S1 | 1 |
| L4-5 alone | 13 | | |
| L5-S1 alone | 37 | | |
| L3-4, L4-5 | 3 | L4-5, L5-6 | 1 |
| L3-4, L5-S1 | 6 | Questionable | 4 |
| L4-5, L5-S1 | 56 | Non-offending in 3 spaces | 3 |
| | | in 2 spaces | 1 |
| L3-4, L4-5, L5-S1 | 25 | | |

* In 1 case that is not reported here L3-4 was offending alone.

3 cases the discogram showed involvement at three levels while the myelogram was completely negative. In the remaining 14 cases there was partial agreement. Detailed breakdown as to the comparative myelographic and discographic findings according to spaces involved and to cases is presented in Tables IV and V.

All the myelographic studies included, in addition to the usual anteroposterior and oblique films of the spinal sac, a lateral film of the filled sac made with the patient prone on the table with the ray directed horizontally. In this position the Pantopaque, because of its weight, lies directly on the anterior aspect of the subarachnoid sac. The table was always tilted in such a manner as to have the oil cover the disk spaces examined (Figs. 2A and 3A). In

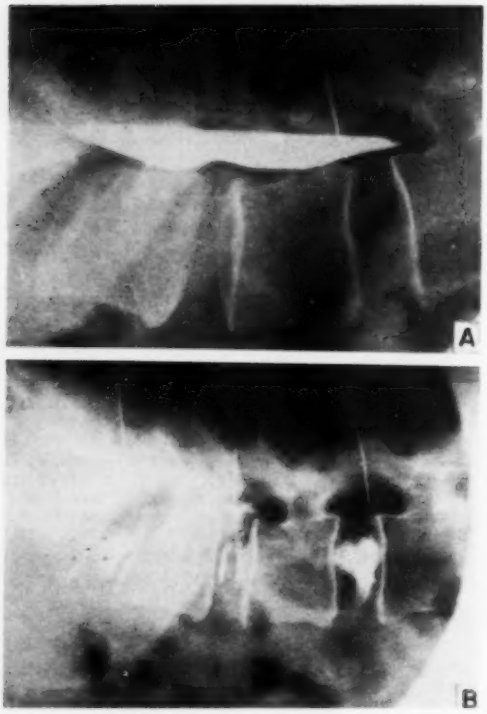

Fig. 2. A. Myelogram, lateral projection in prone position, with horizontally directed ray, demonstrating defect in spinal sac between L4 and L5.

B. Discogram, same projection, demonstrates correlation of the protrusion of the contrast material through the fissures to the indentation of the spinal sac between L4-5 in the myelogram. The spaces above and below are not offending.

TABLE IV: COMPARISON OF MYELOGRAM WITH DISCOGRAM IN 50 CASES ACCORDING TO SPACE

| | L3-4 | L4-5 | L5-S1 | Total |
|---|---|---|---|---|
| Myelogram and discogram both positive | 4 | 19 | 5 | 28 |
| Myelogram and discogram both negative | 32 | 10 | 8 | 50 |
| Myelogram positive; discogram negative | 1 | 2 | 1 | 4 |
| Discogram positive; myelogram negative | 9 | 18 | 30 | 57 |

*Note:* The spinal sac was positioned considerably posterior to the vertebral body and disk in 24 cases.

24 of the 50 cases in which myelography was done, it was learned that over either the L5-S1 or the L4-5 space the anterior aspect of the subarachnoid sac was sufficiently posterior to the posterior aspect of the lumbar vertebrae and the disks that only a relatively large protrusion would be

TABLE V: COMPARISON OF MYELOGRAM WITH DISCOGRAM ACCORDING TO CASE

| | | |
|---|---|---|
| Myelogram and discogram in full agreement | Negative | 4 |
| | Positive | 10 |
| | | 14 |
| Myelogram and discogram not in agreement in any space | Myelogram missed | |
| | Single space | 11 |
| | Double space | 8 |
| | Triple space | 3 |
| | Discogram missed | 0 |
| | | 22 |
| Myelogram and discogram in partial agreement | One space agreement Myelogram missed other space in | 12 |
| | Discogram missed other space in | 2 |
| | | 14 |

manifest by indentation of the sac. In the lateral areas, the nerve root sleeves are in very close contact with the posterior aspects of the disks, and minor protrusions could cause encroachment upon the spinal roots. The lateral protrusion would not be manifest at all by indentation of the more posteriorly placed subarachnoid sac.

*Correlation of the Surgical Findings with the Discogram:* Of the 150 cases for which discograms were obtained, 96 came to operation. Table VI correlates the surgical and discographic findings. In the 27 cases in which one disk space was explored, discographic findings were in full agreement. Among 57 cases with surgical exploration of two spaces, agreement was complete in 52; in 1 there was total disagreement in that both spaces were missed on discography. In 9 of 12 cases in which three disks were explored, there was full agreement. (The term "agreeement" indicated that the surgeon thought the degree of degeneration observed at surgery reflected the degree which was observed on the discogram.)

In this series there were no cases in which disks interpreted at discography as offending were found to be negative on exploration. Spaces which could not be entered for injection and were found positive at surgery were considered as missed on discography in this analysis. In 2 cases referred by other surgeons in which discography was performed, not included in this report, it was brought to the at-

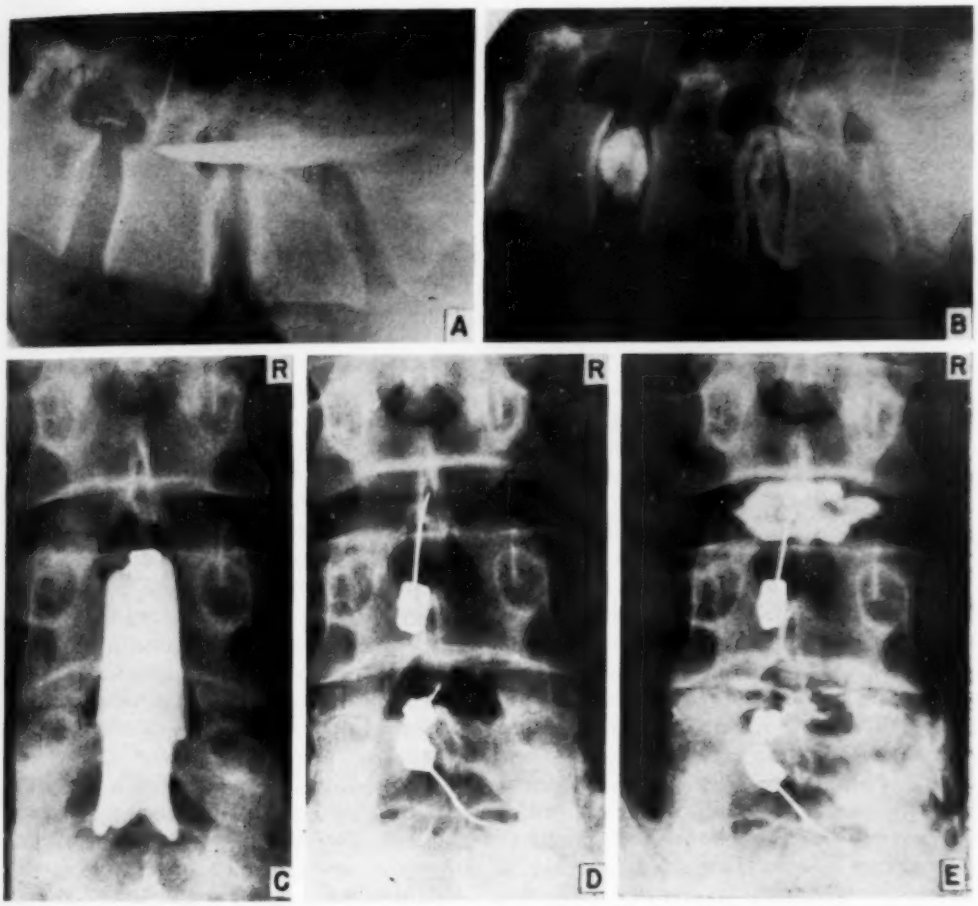


Fig. 3. A and C. Myelograms are negative. Note the space between the spinal sac and the posterior aspects of the body of L5 and the L5-S1 disk space in "A." This separation was observed in 24 of 50 cases in which myelography was done. Poor diagnostic possibilities can be predicted when this anatomical relationship is noted. B, D, and E. Discograms demonstrating the degeneration of the L4-5, L5-S1 disk space. The degree of anterior and posterior protrusion is demonstrated in "B." The lateral spread and leak are noted in "E." The L4-5 and the L5-S1 injection resulted in backache and right leg pain.

tention of one essayist (JF) that the degeneration was not of sufficient degree to have been considered offending by the surgeon. These were considered to be false positives.

*Correlation of Surgical Findings, Discograms, and Myelograms:* In 32 cases both myelograms and discograms were obtained prior to surgery. The comparative findings are tabulated in Table VII. A low rate of agreement between the myelogram and the surgical findings is demonstrated. In cases with multiple space involvement found offending at discography and pathological on surgery, the myelograms were not in full agreement, in that, although one

TABLE VI: CORRELATION OF SURGICAL FINDINGS TO DISCOGRAM IN 96 CASES

| | 1 Disk | 2 Disks | 3 Disks | Total |
|---|---|---|---|---|
| Surgical findings positive | 27 | 57 | 12 | 96 |
| Discogram full agreement | 27 | 52 | 9 | 88 |
| Total disagreement: no. missed | .. | 1 | .. | 1 |
| Partial agreement: no. missed | 7 | .. | .. | 7 |

TABLE VII: CORRELATION OF SURGICAL FINDINGS TO DISCOGRAM AND TO MYELOGRAM IN 32 CASES

| | 1 Disk | 2 Disks | 3 Disks | Total |
|---|---|---|---|---|
| Surgical findings: no. positive | 6 | 20 | 6 | 32 |
| Discogram agreement | 6 | 15 | 3 | 24 |
| Myelogram agreement | 0 | 4 | 0 | 4 |
| Discogram disagreement: no. missed | 0 | 0 | 0 | 0 |
| Myelogram disagreement: no. missed | 6 | 8 | 0 | 14 |
| Discogram, partial agreement: no. missed | 7 | 1 | 0 | 8 |
| Myelogram, partial agreement: no. missed | 9 | 5 | 0 | 14 |

space may have been demonstrated, other spaces were missed.

## DISCUSSION

It is generally agreed that disease originating in the disks is the most frequent cause of low back and sciatic pain. Most patients treated conservatively after variable years of disability will improve and require little more treatment than rest and the passage of time for alleviation of their pain. There is another group, however, with inveterate pain and discomfort which are so completely disabling as to require prolonged bed rest and cessation of work, so that they represent an economic casualty as well. This group is the one to which most attention is devoted and which gives rise to much discussion and argument between surgeons when it comes to the selection of those cases which may be aided by operation or those best treated conservatively. Decisions as to treatment are at times unduly complicated by the fact that many of these patients are snarled in a net of litigation in an attempt to place the burden of blame for the painful condition on others.

Consider the patient with a classical history of prolonged, low backache of sudden onset, with distribution of pain to one leg, with an area of sensory change, reflex change, postural change, motor weakness, and tenderness over the back, who has been disabled for so long a period that spontaneous improvement can no longer be awaited. In this patient the surgical result is usually considered very good. If, in addition to the diagnostic clinical findings, as enumerated, the myelogram shows a single space defect to fit the clinical localization, the diagnosis, of course, will be extremely accurate. In this select group of patients the surgical results are considered the best. Now consider another group of patients, the residue of the previously described select group: the clinical findings are not so clear-cut and clinical localization is difficult, but the patient does have prolonged disabling low back and leg pain; a myelogram may be equivocal or negative. In this group the decision whether to operate or to continue non-operative therapy is not so easily made. Our case material fits largely into this problem group.

The decision to inject three disks in as many patients as possible was made in an attempt to obtain a more complete evaluation of the degree of degeneration that might be present and the number of disk spaces that might be involved.

When the surgeon explores the disk space and observes the posterior aspect of the disk after laminectomy and retraction of the nerve roots and dural sac, he must decide whether to violate the annulus and penetrate into the disk upon the basis of the external appearance of the annulus and the posterior longitudinal ligament. His plan of action would be more easily determinable if he knew the internal structure of the disk preoperatively. Such information is available on proper interpretation of the discogram.

At the onset of this study it was hoped that the discogram would aid in evaluating the disease and selecting those patients who might derive benefit from surgery. Actually the appearance of any one disk gives little indication as to the results to be expected from operation.

It was appreciated that patients with mild degeneration would best be treated conservatively. Such patients had little reproduction of pain on injection (and no

marked epidural leak to explain the absence of pain). The patient with more marked degeneration of three disks is also not a likely candidate for disk surgery.

Ninety-six patients have been operated on, but not until we have completely evaluated the surgical results over a two- or three-year period will it be known if the more thorough investigation with the aid of the discogram and better selection of patients for surgery has been of practical value in relieving symptoms in a significantly high percentage of cases.

By more complete diagnostic evaluation it is hoped that one may better select from that group of patients previously culled and rejected for surgery those who might benefit by operation and be salvaged for useful occupation.

Reports of this kind, however, even before the complete evaluation of the surgical results, are of value in marshalling data and information from various centers, so that the true value of the discogram can be appreciated.

Points for emphasis in this report are as follows:

1. As has been observed by others, reproduction of the pain in the degenerated disk is an accurate sign of the offending nature of the disk. In cases of epidural leak the pain may be slight. Although back pain may be reproduced, leg pain may not be manifest because pressure cannot be raised sufficiently within the disk.

2. The failure of the myelogram in the diagnostic examination has been emphasized in the past. We have been impressed by the finding, on the routine lateral film with the patient prone, of posterior suspension of the anterior aspect of the spinal sac, especially over the L5-S1 level and to a lesser degree over the L4-5 level. If such lateral films with a horizontally directed ray were routinely made in the myelographic study, one could then realize the diagnostic possibilities of the myelogram in these lower lumbar space areas.

3. The demonstration of multiple degenerated disks is very important for complete diagnosis and for the more adequate surgical treatment of the condition. It is understood that when three spaces are involved, the degenerative process is extensive and the surgical results are less satisfactory. This has served as a deterrent in recommending surgery in this group. Although some spaces were not producing immediate symptoms, disk injection did reproduce a pain pattern that may have been present at an earlier time.

4. Twenty-six patients in the series had experienced abdominal, inguinal, or perineal pain associated with the back pain, or these symptoms were produced during the injection of a disk. This is an important clinical feature, in that many patients do complain of such unorthodox distribution of pain with or without backache.

## SUMMARY AND CONCLUSIONS

In 150 cases discography has accurately demonstrated the architectural defects in degenerated disks.

Reproduction of pain upon injection of the contrast medium is a valuable sign in determining the offending nature of the disk.

A comparison with myelography in 50 cases showed the discogram to be more accurate than the myelogram.

One reason for myelographic failure is that the anterior aspect of the subarachnoid sac is posterior to the vertebral bodies over the L4–5 and L5–S1 level.

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SUMARIO

**La Discografía en la Justipreciación de las Lesiones de los Discos Lumbares**

Inyectando un medio de contraste directamente en los discos intervertebrales (discografía) bajo dirección roentgenoscópica, los AA. estudiaron a 150 enfermos que tenían raquialgia incapacitante de larga duración. Hicieron esto en un total de 427 discos.

Este procedimiento puso de manifiesto con exactitud los defectos arquitectónicos de los discos degenerados. La reproducción del dolor al inyectarse el medio de contraste fué un signo valioso para determinar el papel perjudicial del disco.

Una comparación con la mielografía en 50 casos demostró que el discograma es más exacto que el mielograma. Una causa del fracaso mielográfico reside en que la cara anterior del saco subaracnoideo queda detrás de los cuerpos vertebrales al nivel L4–5 y L5–S1.

# Pitfalls of Myelography[1]

W. C. MacCARTY, Jr., M.D.,[2] and F. W. LANE, Jr., M.D.[3]

MYELOGRAPHY is rapidly becoming one of the more important radiological procedures. Within the past nine years at the Mary Hitchcock Memorial Hospital (Hanover, N. H.) there has been a sevenfold increase in the number of these examinations, as compared with a two- or threefold increase in other examinations, such as cholecystography, gastrointestinal series, or intravenous pyelography.

This may be due in part to an increasing number of patients referred to the Clinic as the size and reputation of the Neurosurgical Service have grown. Chiefly, however, myelography's increased importance seems to stem from the realization on the part of the medical profession that it is a safe procedure, does not usually upset the patient, and is invaluable with regard to diagnosis and precise localization of intraspinal lesions.

## REVIEW OF 400 MYELOGRAMS

In order to evaluate our accuracy in this important procedure, it was decided to review 400 consecutive cases in which Pantopaque myelography had been done. Of these patients, we were most interested in 223 who were operated upon, since they afforded an accurate anatomic diagnosis for comparison with the myelographic findings. All roentgenograms were reviewed by the Radiology Department without knowledge of the clinical or operative findings, and the myelographic diagnoses were compared with the observations at surgery. If there was a marked discrepancy such as a normal interpretation in the presence of tumor or ruptured intervertebral disk, the error was classed as a major one. Minor errors were those of localization, differentiation between single and double disks, and technic. Scoville, Moretz and Hankins (1) carried on a similar survey at the Cushing General Hospital in 1948, which showed overall errors in 33 per cent of the cases and revealed that clinical evidence of a ruptured disk is more important than myelographic evidence. Our series is more closely in accord with that of Ramsey, French and Strain (2), who state that the accuracy of myelography in the diagnosis of intraspinal lesions should approximate 95 per cent, which must compare favorably with operative exploration.

The 223 patients who were explored had the following findings at operation. Ruptured intervertebral disk was by far the most common pathological condition, being present in 181 cases (81.2 per cent). Tumor of the spinal cord, meninges, or extradural tissues was present in 19 (8.5 per cent). Six patients (2.7 per cent) had only hypertrophic changes causing myelographic abnormalities. Such ridging was present in much higher percentage in conjunction with other pathological changes, but at operation the ridging was not considered responsible for the disabilities in these patients. The same may be said of the vascular anomalies which were present in 8 cases (3.6 per cent). These consisted of epidural varices or enlarged veins encircling the spinal nerve roots which were almost invariably mistakenly diagnosed as a ruptured disk on the myelogram. Under the heading miscellaneous were grouped such diagnoses as arachnoiditis, congenital anomalies, and trauma. These comprised 1.8 per cent of the total number. In 5 of the operative cases (2.2 per cent) no abnormality was discovered at operation to account for the myelographic finding.

Since ruptured intervertebral disks made up the greatest percentage, these were analyzed for accuracy and error.

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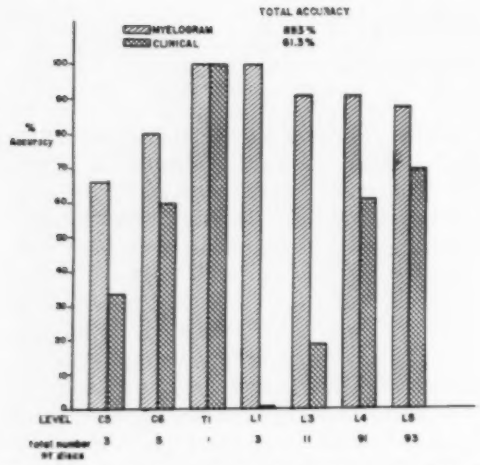


Fig. 1. Comparison of myelographic and clinical accuracy in localization of ruptured disks.

Of the 181 patients operated upon for protruded intervertebral disk, 26 (12.5 per cent) had involvement of more than one intervertebral space. In general the disks occurred most often in the low lumbar region, L 4–5 and the lumbosacral interspaces being involved with almost equal frequency. These two together comprised the location of 88 per cent of the ruptured disks. The L 3–4 intervertebral space was next in frequency with 5.3 per cent. In the cervical region it has been pointed out that the fifth and sixth interspaces are most frequently involved (3), and this was true of the present series, in which the combined levels comprised 3.8 per cent of all the ruptured disks. It is significant that of the 207 disks removed at surgery only 1 (0.5 per cent) occurred in the thoracic region.

The accuracy of myelography in these cases can be judged from a graphic comparison between the clinical and x-ray localization and the surgical findings, as shown in Figure 1. Myelography was correct in 89.3 per cent of the cases as compared with an accuracy of 61.3 per cent clinically.

## PITFALLS OF MYELOGRAPHY

In spite of the overall accuracy of myelography, then, certain errors do occur, and it is the purpose of the remainder of this paper to elucidate some of the pitfalls of the procedure so they can better be avoided in the future.

*Errors Due to the Contrast Medium:* Successful myelography first of all requires the choice of the proper contrast medium. Pantopaque is most commonly used in this country. In spite of its advantages, however, its decreased viscosity may sometimes be disadvantageous. The Pantopaque column tends to separate more readily into droplets, thereby resulting in inadequate examination. Moreover, in the convex thoracic subarachnoid space Pantopaque is not viscous enough to permit the controlled flow and complete filling necessary for recognition of small non-obstructing lesions. This defect can be partially corrected by turning the patient in the supine position and allowing the medium to pool in the normal thoracic curvature. Frequently, however, visualization is still unsatisfactory unless large amounts (10–20 c.c.) are employed. In such a case, Lipiodol (5 c.c.) is the medium of choice. Its viscosity decreases the rate of flow and adequate visualization of a thoracic lesion can then be obtained.

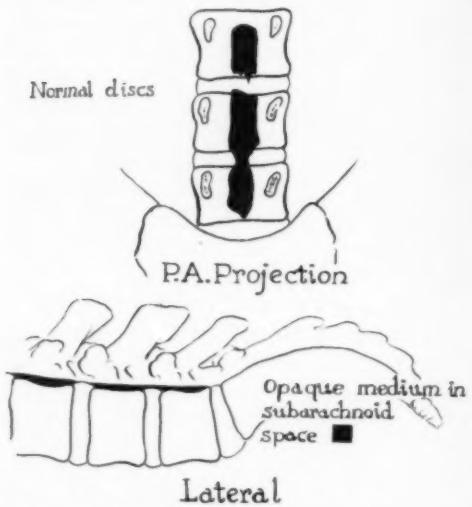


Fig. 2. The bulge of a normal annulus fibrosus may cause interruption or narrowing of the opaque column if insufficient contrast medium is used.

Precise localization of a spinal lesion depends on the use of an adequate quantity of contrast medium. The importance of this fact was first recognized by Odin, Runström, and Lindblom in 1928 (4), but it was unfortunately overlooked by others, so that non-obstructing tumors were frequently missed. It was customary in the past to use 1 to 3 c.c. of the radiopaque oil. This resulted in what Malis, Newman, and Wolf (5) describe as the "thin film technic." The usual contrast media are insoluble and heavier than spinal fluid, and in such small amounts they will pool in the ventral portion of the thecal sac when the patient is prone. This pool is deeper over the concave posterior surfaces of the vertebral bodies and thinner where it covers the normal convexity of the annulus fibrosus. In fact, it may be so thin as to be narrowed or interrupted at the interspace because of these normal anatomic factors (Fig. 2). Such false defects cannot be reproduced and should not be responsible for inaccurate diagnoses. Yet they occupy the attention of the radiologist to the neglect of an actual lesion elsewhere. Furthermore, without complete filling, the oblique views lose much of their usefulness. In those projections the nerve root pouches lie posterolateral to the oil level, with the result that root deformities may easily be missed (Fig. 3a and b). Dependable visualization therefore requires the use of sufficient medium to fill the subarachnoid space completely at the desired level, so that any defect will represent an actual impingement on the sac and can readily be reproduced. This cannot be done effectively with less than 5 c.c. of oil. In many instances larger amounts should be used, depending on the anatomic size and configuration of the subarachnoid space. The old amounts of 1 to 3 c.c. should not be employed except to demonstrate the level of a known obstruction. In such a case it is desirable to leave the Pantopaque in the subarachnoid space rather than to reduce the pressure distal to a lesion.

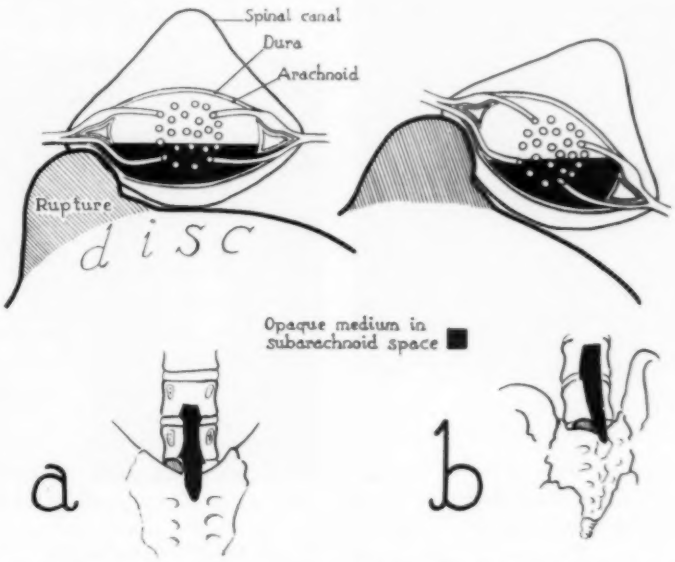


Fig. 3. The root deformity is not seen on the oblique projections because of incomplete filling of the subarachnoid space.

Small amounts were previously advocated because of the erroneous impression that the unpleasant after-effects of myelography could thus be kept to a minimum. In 115 cases reported by Alex Norman (6)

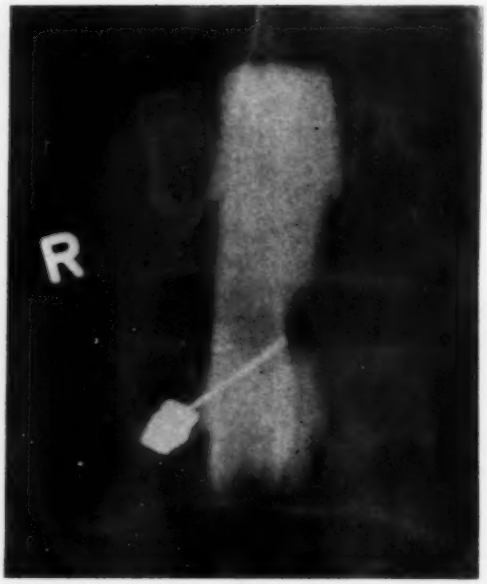


Fig. 4. A needle defect produces a disk-like indentation of the subarachnoid space.

there were fewer reactions to 6 c.c. than to 3 c.c. of Pantopaque and their severity was about the same with both amounts. The incidence of reaction was proportional to the volume of the opaque material left in the subarachnoid space. Norman concluded that myelography is more accurate with the use of larger amounts of Pantopaque and that it is relatively harmless if care is taken to remove as much as possible of the medium after the examination is completed.

*Errors Due to Technic of Injection:* Another source of error in myelography is the faulty injection of the contrast medium. It is always desirable to insert the needle at a distance from the area to be investigated. Since the examination is usually done with the needle *in situ*, defects may be produced by its presence (Fig. 4). These may be the result of displacement of the meninges or nerve roots due to faulty positioning of the needle point, or the result of a traumatic tap with localized hemorrhage causing a disk-like defect in the opaque column. Perforation of the meninges by the needle is occasionally followed by extravasation of cerebrospinal fluid into the subdural space with resultant partial collapse of the subarachnoid space. Normally this subdural space is narrow and contains only enough fluid to moisten the opposing surfaces. After the meninges have been pierced, however, the fluid may separate the arachnoid from the dura and create a large fluid-filled subdural cavity.

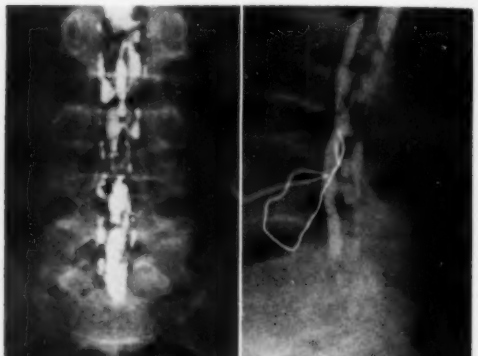

Fig. 5. Subdural injection of the opaque medium.

These needle defects are a definite source of error. They may effectively conceal lesions, thereby causing a false negative report, or they may be responsible for a false positive diagnosis. When the significance of such a defect is in question, the needle should be withdrawn to determine if the defect persists. If so, it is often wise to repeat myelography at a later date, allowing at least a week for the absorption of the extravasated fluid. Another interspace should be chosen for the puncture on the second attempt. For the same reason it is advisable, if possible, to delay myelography for at least a week after a diagnostic spinal tap.

One of the more common technical complications of myelography is the subdural injection of the opaque material (Fig. 5). This may occur if the needle is placed too superficially or too far laterally. Occasionally it results from the bevel of the needle being partly inside and partly outside the subarachnoid space. The oil is

deposited in a cuff-like manner about the periphery of the arachnoid. At first it is contained within a compartment of relatively short length. Then with the pull of gravity it gradually passes between the dura and arachnoid, with cephalic and caudal elongation. Fluoroscopically, the column appears irregular and its movement is sluggish. When this occurs, it is best to remove as much of the oil as possible and repeat the myelogram at a later date.

Extradural injection occasionally occurs when the needle is accidentally dislodged from the subarachnoid space before the oil is injected. The contrast medium is scattered in an irregular fashion in the epidural tissue and frequently follows the nerve roots laterally into the paraspinal soft tissue (Fig. 6). Such a distribution is occasionally seen after routine myelography. In such a case oil unremoved at the end of the procedure apparently leaks with the spinal fluid through the needle defect in the meninges and thus reaches the areolar tissue of the epidural space.

Fig. 6. Extradural injection. The contrast medium follows the nerve roots laterally into the paraspinal soft tissue.

*Errors Due to Inadequate Scope of the Examination:* Another error in myelography is inadequate examination. Since most protruded disks occur at the L 4–5 or lumbosacral interspaces, the examination is often limited to the lower portion of the lumbar subarachnoid space. On other occasions only the level clinically indicated is carefully scrutinized. Multiple disk involvement, however, occurred in 12.5 per cent of our cases, frequently with the symptoms of the larger and more caudally placed disk masking the findings of a second located more cephalad. Moreover, 4 per cent of spinal cord tumors are reported as multiple (3) and these may often produce the symptoms of a ruptured disk. Thus the subarachnoid space should be scanned from the cul-de-sac to the mid-thoracic region in order to avoid overlooking other pathological lesions.

*Errors Due to Vertebral Anomalies:* Variation in the number of lumbar vertebrae and anomalies of sacralization of the last lumbar body are common and occasionally lead to miscalculation of the level of a lesion. To minimize the chance of operative repair being initiated at the wrong level, conventional Bucky postero-anterior and grid lateral spine films should be taken with the Pantopaque pooled at the suspicious area. These clearly visualize the column outlining the lesion and establish the relationship to the vertebrae. When there are six lumbar-type vertebrae it is occasionally difficult, even with the conventional films, to establish definitely the level without benefit of roentgenograms of the entire spine to localize accurately the first lumbar vertebra. In such cases the radiologist should adopt a manner of reporting which is consistent and understood by the neurosurgeons.

*Errors Due to Normal Variations in Size and Shape of the Subarachnoid Space:* Patients with a narrow subarachnoid space and a large quantity of epidural areolar tissue between the thecal sac and the vertebral canal offer great diagnostic difficulty. Discrepancies occur usually when the subarachnoid space measures 16 mm. or less.

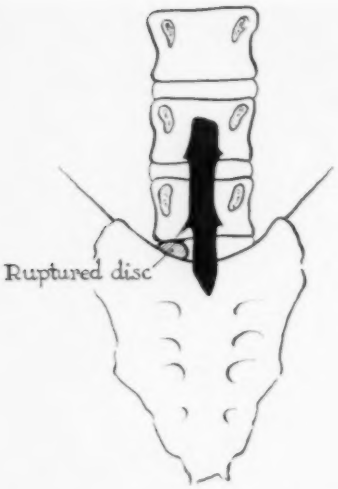


Fig. 7. Laterally placed disks may produce no deformity in case of a narrow subarachnoid space.

In such cases, small laterally placed disks may be imbedded in the areolar tissue without causing any indentation of the opaque column (Fig. 7). If they also fail to cause edema or displacement of the contiguous nerve roots, they are not detectable. Therefore, when the width of the opaque shadow is less than 16 mm., a "normal" myelogram does not exclude a ruptured disk and the diagnosis depends on the clinical findings.

At the opposite extreme, patients with a large subarachnoid space and little epidural areolar tissue may show shallow irregularities of the column on the grid lateral film. These represent not herniations but normal posterior bulges of the annulus fibrosus (Fig. 8), which can usually be reduced with decrease of the lumbar curvature.

Anatomic variations in the shape of the cul-de-sac are also a frequent cause of myelographic error and are responsible for the fact that the ruptured disks most frequently missed occur at the lumbosacral interspace. At this level there is considerable narrowing of the subarachnoid space prior to its termination at S 2. Not only does this occur in the frontal projection but there is also dorsal tapering of the ventral margin, which may be responsible for a rather thick space between the anterior aspect of the column and the lumbosacral interspace. This is frequently large enough to conceal a ruptured disk of considerable size (Fig. 9).

In 5 per cent of cases there may be a short cul-de-sac terminating one or several segments more cephalad than usual. This likewise increases the possibility of missing a ruptured lumbosacral disk (Fig. 10).

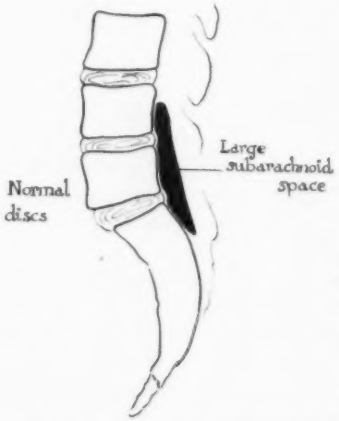


Fig. 8. A normal disk may produce deformity of the opaque column in case of a large subarachnoid space.

*Errors Due to Previous Procedures:* In patients who have had previous myelography, laminectomy, spinal anesthesia, or occasionally even diagnostic lumbar punctures, the interpretation of indentations of the opaque column becomes more difficult. Adhesions and scarring will often produce defects which are hard to analyze. Thickened meninges will also cause atypical deformities with associated transitory arrest of oil deposits. These are frequently located posteriorly and may sometimes be differentiated by the use of grid lateral films.

## ADEQUATE FILMS

While major lesions can usually be diagnosed fluoroscopically, it is useful to have adequate films for study when the deformities of the opaque column are of a subtle nature. It should be a policy therefore to

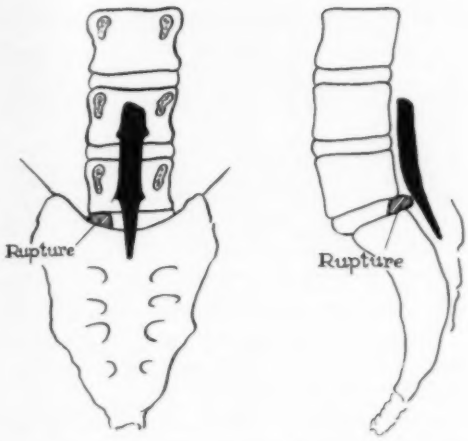


Fig. 9. Anatomic narrowing of the cul-de-sac may conceal a ruptured lumbosacral disk.

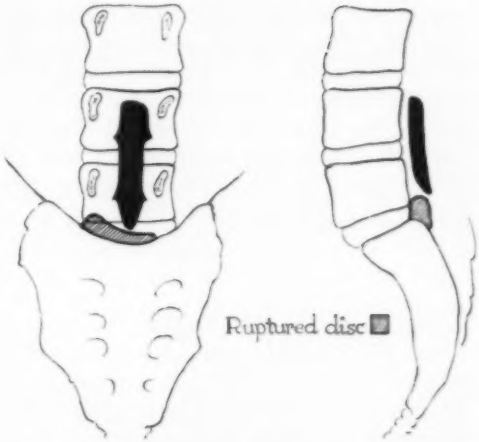


Fig. 10. A short cul-de-sac may conceal a ruptured lumbosacral disk.

take spot films of areas in question at the time of fluoroscopy. These should include not only frontal projections large enough to allow accurate localization, but also oblique views which will show anterolateral impingement on the subarachnoid space more prominently. It is the policy of our radiology department to take a conventional postero-anterior Bucky and grid lateral films after fluoroscopy. The former is useful to establish the general relationship of the lesion to the vertebral bodies; the latter is taken using a horizontal x-ray beam without changing the prone position of the patient and is invaluable in differentiating deformities of the anterior surface of the opaque column, such as hypertrophic ridging and spondylolisthesis (Fig. 11). Occasionally it is the only view in which a ruptured intervertebral disk is visualized.

Fig. 11. The grid lateral film is useful in differentiating deformities due to spondylolisthesis.

## X-RAY APPARATUS

A final word should be said with regard to the apparatus necessary for successful myelography. The fluoroscopic table should tilt not only 90° in the caudal direction but also at least 45° Trendelenburg. This overcomes the necessity for reversing the patient on the table to permit a greater degree of tilt. This latter manipulation is not only difficult for an ill person but often results in loss of control of the opaque medium in the subarachnoid space. The patient should be put at ease by being well supported by shoulder braces and a compression band across the thighs. The table preferably should have a hydraulic tilting device to permit it to stop and start without undue jerking, which is often

responsible for the break-up of the opaque medium. It is advantageous for the radiologist to be able to control the tilting from the fluoroscopic tower so that he may watch the column in motion. Otherwise, the only equipment necessary is that required for the taking of ordinary spot films with a rotating anode tube.

SUMMARY

In a review of 400 consecutive cases in which Pantopaque myelography was performed, this procedure was found to be 89.3 per cent accurate in localizing ruptured intervertebral disks. Certain errors, however, do occur, and an attempt is made to elucidate their causes so that they can be avoided in the future.

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SUMARIO

**Escollos de la Mielografía**

Del repaso de 400 casos consecutivos en que se ejecutó la mielografía con Pantopaque, se deduce que este procedimiento alcanza una exactitud de 89.3 por ciento en la localización de los discos intervertebrales quebrados. Los errores de diagnóstico proceden de varias causas. Entre ellas, figuran la naturaleza y la cantidad del medio de contraste, defectos en la técnica de inyección, plan inadecuado de examen, presencia de anomalías o alteraciones vertebrales (adherencias, tejido cicatricial) debidas a intervenciones anteriores y variaciones normales del tamaño y de la forma del espacio subaracnoideo.

Opinan los AA. que el Lipiodol posee ciertas ventajas sobre el Pantopaque, que es menos viscoso, y que debe usarse a lo menos 5 c.c. del aceite. Debido a la posibilidad de lesiones múltiples de los discos y de otros estados patológicos, el examen debe comprender el espacio subaracnoideo desde el fondo de saco hasta la región mesotorácica. La roentgenoscopia debe complementarse con radiografías instantáneas y radiografías corrientes.

# The Roentgenologic Aspects of Chronic Ulcerative Colitis in Children[1]

JOHN R. HODGSON, M.D., and ROGER L. J. KENNEDY, M.D.

THIS IS A review of 122 cases of ulcerative colitis in children seen at the Mayo Clinic between January 1944 and January 1954. Numerous articles have appeared describing the disease in adults (1–4), and in 1940 Jackman, Bargen, and Helmholz (5) reported 95 cases in children. These latter writers stated that ulcerative colitis is apt to be more severe among children than among adults, with a poorer response to treatment and more complications. When the disease occurs in childhood, general growth and development are often diminished.

The present paper concerns particularly the roentgen aspects of the condition. In each case some combination of clinical, roentgenologic, and proctoscopic evidence of idiopathic chronic ulcerative colitis was present. Amebiasis and tuberculous ulcerative colitis have been excluded from this study.

Chronic ulcerative colitis occurs almost twice as often among boys as among girls; 76 of the 122 children whose cases we reviewed were boys. The cases were divided rather arbitrarily into the following groups, based on the age of the patient: birth to four years, 11 cases; five to nine years, 28 cases; ten through fifteen years, 83 cases. The disease occurs with increasing frequency up to fifteen years of age. Early adolescence appears to be a particularly dangerous time because of rapid progression of the disease and severe changes in short periods.

We have not seen chronic ulcerative colitis in a child less than eighteen months of age. Dr. John W. Hope (6) of Philadelphia, however, has observed a case in an infant of six weeks, the youngest patient of whom we have heard with this disease.

## CLINICAL ASPECTS

The onset of chronic ulcerative colitis in childhood may be gradual and insidious or it may be sudden. Its type has a bearing on the roentgenologic findings, since, if there is a rather sharp onset of bloody diarrhea, extensive roentgen changes may be apparent within less than two weeks.

Bloody diarrhea is characteristic of the disease and, with few exceptions, is present in every case. Frequently the onset is related to some inflammatory episode involving the respiratory tract.

Of equal value with the roentgenologic study is the proctosigmoidoscopic examination. The correlation between the proctoscopic findings and the roentgenologic manifestations of early disease is very good. Rarely (3 cases) will the roentgenologic findings be negative if the proctoscope shows evidence of ulcerative colitis. Similarly, positive roentgenographic evidence of disease is uncommon (6 cases) in the face of negative proctoscopic findings. Apparently no time lag exists between the proctoscopic diagnosis of chronic ulcerative colitis and the roentgenologic diagnosis. A careful review of the cases reported here reveals no significant difference in the diagnostic results of these procedures; it serves only to emphasize the necessity of both examinations.

The types of ulcerative colitis have been described by Weber and Bargen (1). Type 1 is the most frequently encountered form of the disease, with roentgenologic findings and proctoscopic changes beginning in the rectum and progressing orad. In Type 2 there is roentgenologic evidence of the disease, but the proctoscopic manifestations are either equivocal or lacking.

[1] From the Sections of Roentgenology (J. R. H.) and Pediatrics (R. L. J. K.), Mayo Clinic and Mayo Foundation, Rochester, Minn. The Mayo Foundation is a part of the Graduate School of the University of Minnesota.
Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

Type 3 reveals an unusual proctoscopic appearance with a peculiar mucosal pattern and ulcers in the rectum and sigmoid. These patients frequently show roentgenologic evidence of disease in the right side of the colon and normal appearing areas in other segments. In 5 of our cases ulcerative colitis, Type 3, was suggested by the proctoscopist. These cases presented an unusual mucosal pattern, with ulcers in the rectum and sigmoid apparent on proctoscopy. The roentgen examination revealed definite evidence of chronic ulcerative colitis primarily in the right portion of the colon.

### DISTRIBUTION

It is known that in a certain percentage of adult patients only a segment of the bowel will be involved. This may be the rectum, the sigmoid, or any other portion of the colon. Also chronic ulcerative colitis may involve the right half of the colon and spare the remainder, although this rarely occurs. In these cases the proctoscopic picture is usually atypical, with patchy areas of reddened, edematous mucous membrane and occasionally ulcers. In the series reported here, the roentgenograms were reviewed without any knowledge of the history or proctoscopic report, in an effort to establish distribution of the disease solely on a roentgenologic basis. It was found that in only 1 case was the right side of the colon involved and in only 3 cases was the disease limited to the left half of the colon. In 1 case the rectum and sigmoid were involved; in all others the entire colon was affected, although in some instances the degree of involvement was minimal. This seems unusual, since in many of these cases diagnosis had been made shortly after onset, and one would expect to see more segmental involvement of the colon among children. In 96 per cent of the series, however, the entire colon was involved, no matter how long the disease had been present or how severe the involvement. It is of interest that in those cases in which ulcerative colitis was associated with regional enteritis, the entire colon was involved when we first saw the patient.

### ROENTGENOLOGIC ASPECTS

Weber (2) has said that the roentgen manifestations of all forms of ulcerative colitis reflect the gross morphologic changes produced by the pathologic process in the size, shape, and contour of the part of the intestine affected.

The roentgen examination of the colon for evidence of chronic ulcerative colitis consists of roentgenoscopy during administration of a barium enema and of evaluation of changes apparent on a roentgenogram obtained after evacuation. The roentgen diagnosis should be based on a correlation of these findings.

Satisfactory roentgenoscopic examination depends in a large measure on adequate preparation of the patient. In the case of children, this involves careful attention to the attitude of the patient as well as purgation of the bowel. An attempt should be made to allay the fears and natural resistance of the child to this procedure by careful explanation of the examination and the reasons for its necessity. If this fails, or the child is too young for explanation, the examiner must be prepared to be patient and understanding. It has been our experience that complete cleansing of the bowel in children is difficult, but every effort should be made to accomplish it. Sufficient quantities of gas, fecal material, and intestinal secretion are present in the unprepared colon to interfere significantly with accurate roentgenologic diagnosis. This is true even in the presence of active diarrhea. Under these circumstances, severe purgation is contraindicated, but a mild non-saline cathartic drug, supplemented by a few warm enemas of physiologic saline solution, is generally satisfactory. In the absence of diarrhea, castor oil is required for preparation.

*Roentgenoscopic Examination:* The technic in use at the Mayo Clinic for the administration of a barium enema has been described many times (3, 4). Any technic is permissible, provided it permits examina-

tion of every part of the large bowel visually and with palpation. Roentgenoscopic examination of the colon in children is complicated by the necessity for speed without sacrifice of accuracy. There is hyperirritability, either segmental or diffuse, in all cases of ulcerative colitis, and this, together with fear or a disinclination to retain the enema, may interfere considerably with satisfactory completion of the procedure.

TABLE I: CORRELATION OF NARROWING AND SHORTENING OF COLON WITH AGE OF PATIENT

| Age (years) | Narrowing and Shortening Graded on Basis of 1 to 3* | | | | Total |
|---|---|---|---|---|---|
| | No Change | Grade 1 | Grade 2 | Grade 3 | |
| 0 to 4 | 6 | 4 | 1 | 0 | 11 |
| 5 to 9 | 9 | 8 | 8 | 3 | 28 |
| 10 through 15 | 26 | 26 | 20 | 11 | 83 |
| TOTAL | 41 | 38 | 29 | 14 | 122 |

* Grade 1 represents the least degree of narrowing and shortening and Grade 3 represents the greatest degree.

The roentgenoscopic manifestations of chronic ulcerative colitis in children are no different than they are in the adult. The changes depend entirely on the degree of involvement of the bowel and the stage of the disease. Briefly the recognizable findings are narrowing and shortening of the bowel; thickening of the wall, determined by palpation; polypoid hyperplasia; and destruction of the mucous membrane. These manifestations are those of moderately advanced chronic ulcerative colitis rather than of early or minimal involvement.

Distention of the colon with barium and water may obscure the early changes of chronic ulcerative colitis which originate in the mucous membrane. Superficial abscesses may be recognizable during roentgenoscopy, but the more frequently encountered mucosal pattern of chronic ulcerative colitis may be completely obscured and often roentgenoscopy will fail to provide the examiner with any clear-cut evidence of the disease in its early stages.

TABLE II: RELATION OF MUCOSAL CHANGE TO AGE OF CHILD

| Age (years) | Changes in Mucous Membrane Graded on Basis of 1 to 3* | | | | Total |
|---|---|---|---|---|---|
| | No Change | Grade 1 | Grade 2 | Grade 3 | |
| 0 to 4 | 1 | 6 | 4 | 0 | 11 |
| 5 to 9 | 0 | 10 | 10 | 8 | 28 |
| 10 through 15 | 0 | 22 | 45 | 16 | 83 |
| TOTAL | 1 | 38 | 59 | 24 | 122 |

* Grade 1 represents the least degree of change and Grade 3 represents the greatest degree.

*Roentgenographic Considerations:* Roentgenograms made immediately after evacuation of the barium enema are uniformly satisfactory in children, provided the technical factors are adequate. Apparently the hyperirritability of the colon provides for more adequate emptying of the large bowel, and demonstration of the important mucous-membrane pattern is facilitated. The roentgenographic criteria for the diagnosis of ulcerative colitis consist in narrowing and shortening of the bowel, destruction of the mucosal pattern, superficial or submucosal abscesses, and presence of a sinus tract or pseudopolyp.

In children, narrowing and shortening of the colon, when present, are evident on the roentgenogram. An effort was made to correlate the degree of shortening and narrowing with the age of the patient and the duration of the disease, a rather arbitrary grading of 1 to 3 being adopted. As shown in Table I, the most serious changes occur among patients ten to fifteen years of age. As would be expected, the severest changes were observed in children with the longest history of disease. In 48 of the 122 children the duration was less than one year, while 74 had signs and symptoms for more than a year. Ten patients still had no narrowing or shortening after having had the disease for more than two years.

The mucous-membrane pattern is probably the most important single factor in the diagnosis of chronic ulcerative colitis at any age. At proctoscopic examination, the mucosa is seen as an edematous reddened membrane which bleeds easily when

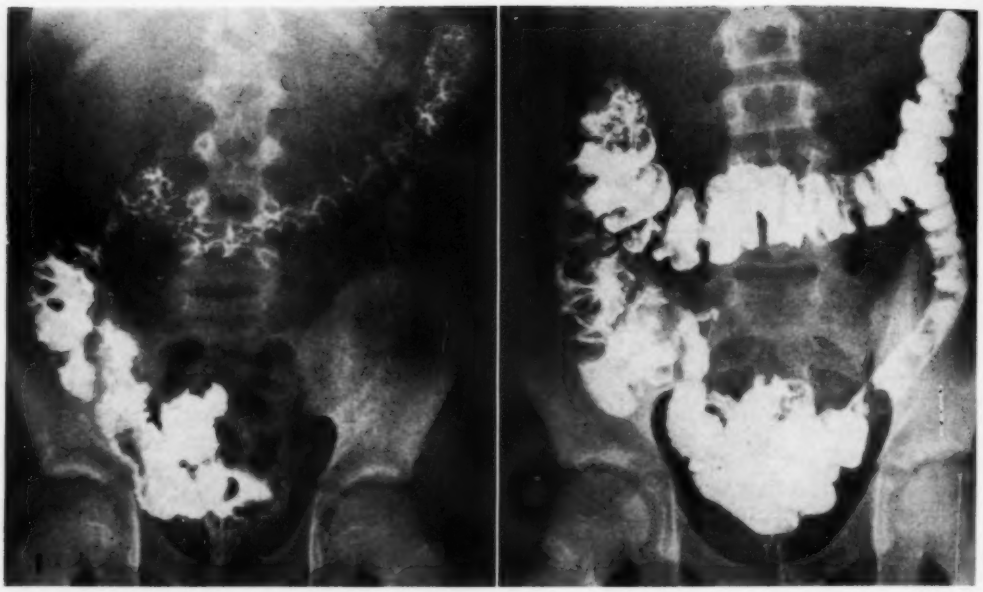

Fig. 1. Boy, age 11 years, with progressive bloody diarrhea for one year. Mucous membrane pattern of chronic ulcerative colitis with involvement of terminal portion of ileum.

Fig. 2. Boy, age 12 years, with history of bloody diarrhea for three weeks. Early stages of ulcerative colitis noted at proctoscopic examination. Numerous tiny mucosal abscesses.

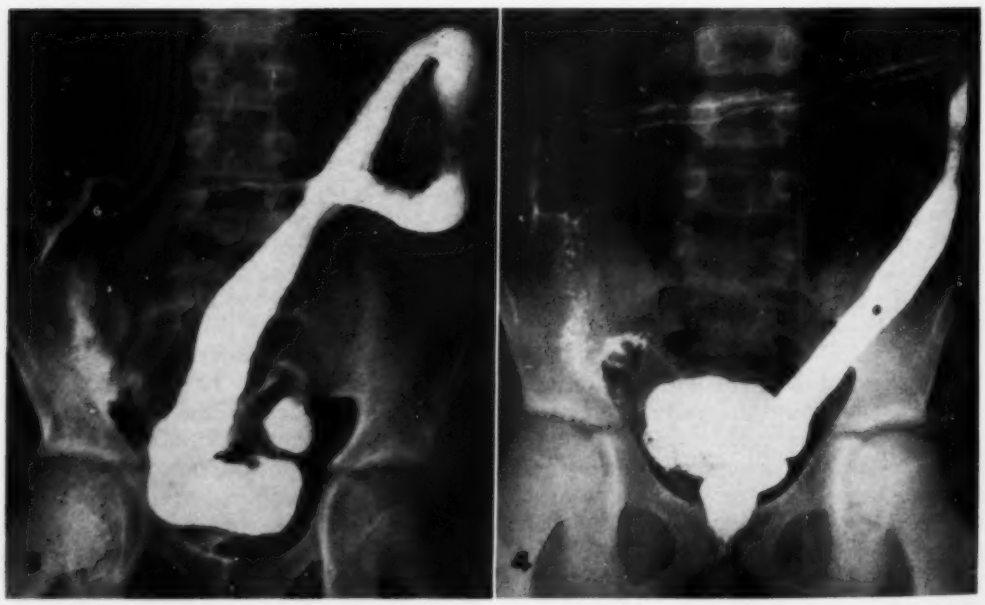

Fig. 3. Boy, age 11 years. Onset of disease six months before admission to the clinic. Rapid progression. Mucous membrane destroyed.

Fig. 4. Boy, 14 years of age. Onset at age of seven, with bloody diarrhea. Colon shortened and narrowed; mucous-membrane pattern destroyed.

touched. On the roentgenogram, it appears fuzzy or feathery. The folds are thickened and do not appear sharp and clear. This is probably attributable partly to edema and partly to abnormal intestinal secretions. There may be segmental involvement of the mucous membrane, with changes confined to the rectum and sigmoid, or the entire bowel may be involved, and the terminal portion of the ileum as well. Some degree of mucosal alteration

TABLE III: RELATION OF DURATION OF SYMPTOMS TO DEGREE OF CHANGE IN MUCOUS MEMBRANE

| Duration of Symptoms | Changes in Mucous-Membrane Pattern Graded on Basis of 1 to 3* | | | | Total |
|---|---|---|---|---|---|
| | No Change | Grade 1 | Grade 2 | Grade 3 | |
| Less than 3 months | 1 | 9 | 7 | 0 | 17 |
| 3 months to less than 1 year | 0 | 12 | 14 | 5 | 31 |
| 1 year to less than 2 years | 0 | 8 | 16 | 3 | 27 |
| More than 2 years | 0 | 10 | 22 | 15 | 47 |
| TOTAL | 1 | 39 | 59 | 23 | 122 |

* Grade 1 represents the least degree of change and Grade 3 represents the greatest degree.

was recognizable on the roentgenograms in all but one of our cases. It was found that the older the child, the more likely was the presence of severe changes (Table II). The degree of destruction, however, was not so closely related to the duration of symptoms. Patients having a relatively short history of disease may show extensive destruction of the mucous-membrane pattern. All patients with a long history showed some change (Table III). Roentgenographic evidence of a flat, smooth bowel indicates complete destruction of the mucous membrane.

Change in the mucosal pattern is recognized as the earliest roentgen sign of chronic ulcerative colitis. Early in the course of the disease the mucous membrane may appear fuzzy and feathery on the roentgenogram (Fig. 1), or it may have a jagged, serrated sawtooth appearance (Fig. 2). We cannot be certain, but we suspect that these serrations are small, superficial ulcers. Occasionally a similar appearance is encountered in the normal colon. The serrations in colitis, however, are more irregular and are deeper and larger than those occurring in the well prepared normal bowel. In many of the cases in which this pattern of serration is present, the history of the disease is short. Furthermore, these children seem to get along better with treatment. With a duration of symptoms of less than three months, the pattern which was most frequently encountered was that of the serrated or pitted mucous membrane.

Fig. 5. Boy, age 5 years. Onset of disease with diarrhea at age of three years; bloody diarrhea at four years of age. Roentgenogram reveals destruction of mucous-membrane pattern, with large submucosal abscesses.

As the disease progresses, the mucous membrane is gradually destroyed and replaced with scar tissue, leaving only scattered islands of mucosa. With complete destruction, the roentgenogram will show only a relatively flat, slightly irregular pattern (Figs. 3 and 4).

Fig. 6. Girl, age 13 years. Three-year history of diarrhea and pain. Scarred contracted colon with ulcers, pseudopolyps, abscesses, and a large sinus tract arising from the rectum.

COMPLICATIONS

*Abscesses* occur not only near the surface of the mucous membrane but may extend submucosally, in which event they may enlarge and perforate, causing peritonitis or extracolonic abscesses (Fig. 5). Fortunately this appears to be a fairly rare complication of the disease. With perforation, sinus tracts occur. One patient in our series had a sinus tract extending into the perirectal soft tissues (Fig. 6). Definite abscesses were evident on the roentgenograms in 10 of the 122 cases. Superficial ulceration, however, is easily demonstrated and any superficial ulcer could be associated with an abscess. More than a third of the roentgenograms revealed some degree of superficial ulceration.

*Pseudopolyps* (Fig. 7), or secondary polypoid hyperplasia, were present in 25 cases. These are due to hypertrophy of islands of mucosa left in the colon after acute ulceration subsides. Pseudopolyps occur in cases of moderately advanced ulceration, the average duration of the disease when secondary polypoid hyperplasia is encountered being about two and a half years. Seven of the 25 children with pseudopolyposis, however, had had symptoms for less than a year. The polyps are easily demonstrated, both roentgenoscopically and roentgenographically. They are usually

Fig. 7. Girl, 9 years of age. History of blood in stools for a year and a half. No diarrhea. Polypoid hyperplasia and mucosal ulceration. Chronic ulcerative colitis at proctoscopic examination.

numerous, variable in size, and do not present a diagnostic problem. They must be carefully watched, however, since they may become carcinomatous and may be an indication for colectomy. No cases of carcinoma were found in the present series.

The roentgenograms revealed *involvement of the terminal portion of the ileum* in at least 16 cases. It was difficult to determine accurately the number of cases in which such involvement was present, since oftentimes the terminal portion of the ileum either was not filled or was obscured by loops of overlying bowel. There appears to be no correlation between involvement of the terminal portion of the ileum and

the severity of disease or its duration. Ileal involvement was present in cases with histories ranging from two months to seven years, and in cases in which the changes ranged from severe to very mild (Fig. 8). Extension of disease from the colon to the terminal portion of the ileum is not uncommon, and usually only a few inches of this part of the ileum are involved.

In patients having regional enteritis which secondarily involved the right side of the colon, the proctoscopic appearance was quite different from that seen in association with chronic ulcerative colitis, Type 1. Figure 9 shows the typical far advanced regional enteritis which had been present for years and Figure 10 reveals the typical mucous-membrane pattern of chronic ulcerative colitis. The roentgenographic manifestation of these two diseases is very similar and there is apparently some close etiologic relationship. In 4 of our cases chronic ulcerative colitis started

Fig. 8. Boy, age 3 years. There was a history of bloody diarrhea having its onset at the age of two years and nine months. Proctoscopic examination revealed typical chronic ulcerative colitis. Roentgenogram shows feathery, fuzzy mucous-membrane pattern of ulcerative colitis.

Fig. 9. Boy, age 15 years. Onset of regional enteritis at fourteen years of age. Extensive mucosal ulceration and fistulous formation in the ileum.

Fig. 10. Mucosal changes typical of chronic ulcerative colitis in the same patient, suggesting some relationship to regional enteritis.

Fig. 11. Girl, age 2½ years. Two-year history of loose stools. Proctoscopic examination revealed only reddened mucosa. History of cystic fibrosis of pancreas not compatible with ulcerative colitis. Note changes in mucous membrane.

as regional enteritis, and in each instance the small intestine was extensively involved. Roentgenographic manifestations of disease in the colon which were indistinguishable from chronic ulcerative colitis developed later in all of these children.

## DIFFERENTIAL DIAGNOSIS

It is not difficult to explain the association of regional enteritis and the development of a roentgenographic pattern in the colon which is indistinguishable from chronic ulcerative colitis. Occasionally, however, the roentgenologist will be confronted with the typical roentgenographic manifestations of ulcerative colitis (Fig. 11), though the clinical story will not be consistent with the disease and the proctoscopist will be unable to confirm its presence. Two such cases occurred in the present series: one patient had nephritis with edema and ascites, and the other cystic fibrosis of the pancreas. It should be noted that any condition that may produce edema or superficial erosion of the mucous membrane can simulate the roentgenologic criteria for the diagnosis of chronic ulcerative colitis. As pointed out above, chronic ulcerative colitis tends to be more severe in children from ten to fifteen years of age. Changes in the bowel evident on roentgenologic examination are more marked and complications are more frequent. The disease is rare in infants. The younger the child, the better the chance of both clinical and roentgenologic improvement.

## SUMMARY AND CONCLUSIONS

The differences between chronic ulcerative colitis of idiopathic origin in adults and in children are minor. The disease manifests itself in the same fashion and the same roentgenologic criteria for diagnosis apply.

Both the proctoscopist and the radiologist provide valuable diagnostic information to the clinician. Diagnosis depends on correlation of clinical, proctoscopic, and roentgenologic information.

It appears that there is more chance of recovery if the disease is detected early in a child, and we are of the opinion that in the prepuberty group there appears to be less roentgenologic evidence of complications. Chronic ulcerative colitis in children, while a formidable disease, may be susceptible to control, if detected early and managed carefully.

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SUMARIO

**Los Aspectos Roentgenológicos de la Colitis Ulcerada Crónica en los Niños**

Ciento veintidós casos de colitis ulcerada en niños hasta de quince anos de edad fueron repasados con referencia particular a los hallazgos radiológicos.

Las diferencias entre la colitis ulcerada crónica de género idiopático en los adultos y los niños son menores. La enfermedad se manifiesta en la misma forma y rigen las mismas pautas roentgenológicas para el diagnóstico.

Tanto el proctoscopista como el radiólogo aportan valiosa información al clínico. El diagnóstico se basa en la correlación de los datos clínicos, proctoscópicos y clínicos.

Parece que hay más probabilidades de curación si se descubre la dolencia tempranamente en un niño, y opinan los AA. que en el grupo prepúber parece haber menos signos roentgenológicos de complicaciones. La colitis ulcerada crónica en los niños, aunque enfermedad formidable, puede ser susceptible de dominio, si se descubre tempranamente y se atiende con cuidado.

# Coexistent Tuberculosis and Carcinoma of the Lung[1]

HARRY HAUSER, M.D., and NORMAN M. GLAZER, M.D.

THE GREATER LIFE span of man has resulted in an apparent increase in the so-called "chronic diseases," including tuberculosis and carcinoma of the lung. That these diseases may occur concomitantly has been noted previously in the literature. There have been numerous opinions as to the possible causal relationships between them. Hambly (1) has listed the arguments with respect to the four etiologic possibilities: (*a*) carcinoma and tuberculosis are antagonistic; (*b*) tuberculosis of the lung is a precursor of bronchogenic carcinoma; (*c*) carcinoma predisposes to tuberculosis; (*d*) no specific relationship exists between the two conditions. From the historical aspect, it is interesting to note that Rokitansky (2) believed that carcinoma and tuberculosis were antagonistic. Ewing originally regarded tuberculosis as a precursor of lung carcinoma. Only later did he consider his earlier point of view probably incorrect. The weight of the evidence would indicate that no significant relationship exists between pulmonary tuberculosis and bronchogenic carcinoma.

The problem of differential diagnosis of lung disease is a difficult one, oft compared to the study of trees in a forest, with great similarity but with some differentiating characteristics. Errors in the differentiation of pulmonary tuberculosis from bronchogenic carcinoma by roentgenologic means are not infrequent. Clinical proof of active pulmonary tuberculosis is inferred if sputum examination is positive for the tubercle bacilli. Yet this conclusion is not always true. Maxwell (3) reported the finding of tubercle bacilli in the sputum of 10 per cent of patients with malignant lung disease. Drymalski and Sweany (4) found acid-fast bacilli in the sputum in 15 of 57 cases of bronchogenic carcinoma, though at autopsy 7 of the 15 showed no sign of tuberculosis. The radiologist is correctly swayed by the finding of tubercle bacilli in the sputum as indicating tuberculosis in the lung in the vast majority of cases. However, an atypical roentgen appearance for tuberculosis should suggest the possibility of some other process as the etiologic factor.

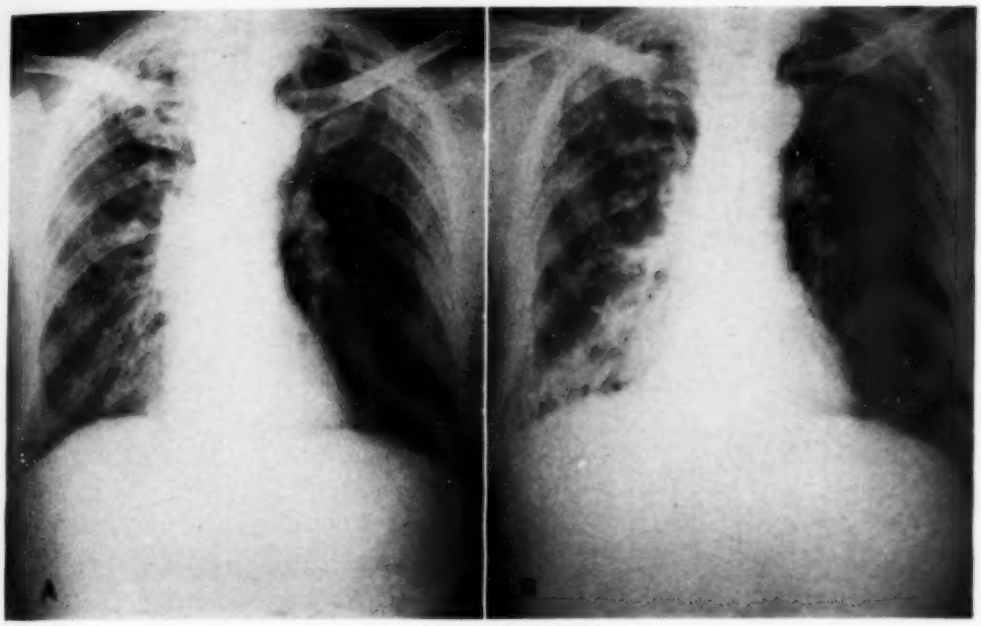
There are cases which show roentgen evidence of pulmonary tuberculosis plus some other feature which is not usually seen in that disease. It is in these cases that the radiologist must alert the clini-

TABLE I: COEXISTENT TUBERCULOSIS AND CARCINOMA OF THE LUNG

| Author | Cases with Radiographs | Prominent Hilus | Atelectasis or Collapsed Lobe | Homogeneous Lobar Density | Nodular Densities (over 3 cm.) | Paratracheal Lymph Node Enlargement | No Characteristic Features |
|---|---|---|---|---|---|---|---|
| Shefts and Hentel | 3 | 1 | ... | ... | ... | ... | 2 |
| McCorkle *et al.* | 1 | 1 | 1 | ... | ... | ... | ... |
| Graham | 1 | ... | ... | 1 | ... | ... | ... |
| Robbins and Silverman | 7 | 1 | ... | 3 | ... | 1 | 2 |
| Helm and Moon | 5 | 4 | 1 | 1 | 1 | ... | ... |
| Attinger | 5 | 1 | 1 | 1 | ... | ... | 2 |
| Gerstl *et al.* | 3 | 1 | ... | 2 | ... | ... | ... |
| Fried | 1 | 1 | ... | ... | ... | ... | ... |
| Hauser and Glazer | 10 | 5 | 3 | 3 | ... | 1 | 2 |

Note: In several cases, more than one roentgen feature was present.

[1] From the Department of Radiology, Cleveland City Hospital and Western Reserve University School of Medicine, Cleveland, Ohio. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.



cian to the possibility that more than one disease may be present.

This study concerns itself with 10 cases of concomitant pulmonary tuberculosis and carcinoma. In most of these, it was possible to determine that tuberculosis appeared first. The literature (5–14) was reviewed to ascertain which roentgen features might suggest that tuberculosis was complicated by carcinoma. These points include:

1. The presence of a prominent hilus.
2. The presence of paratracheal lymph node enlargement.
3. The presence of an atelectatic or collapsed lobe.
4. The appearance of a homogeneous segmental or lobar density in the lower lung fields.
5. The presence of large (over 3 cm.) discrete nodular densities.

Table I lists recorded cases of concomitant pulmonary tuberculosis and carcinoma in which radiographs are included in the report and the radiological findings suggesting the carcinomatous element are mentioned.

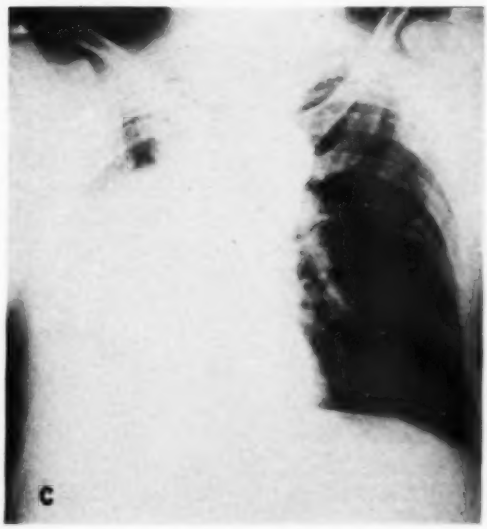


Fig. 1. Case I. Postero-anterior roentgenograms from Feb. 4, 1937, to Jan. 24, 1939, showing the development of a homogeneous density in the lower three-fourths of the right lung.

## REPORT OF CASES AT CLEVELAND CITY HOSPITAL

CASE I (Fig. 1): S.M., a 56-year-old white male, was admitted to the hospital on Sept. 14, 1937, complaining of fever, fatigue, shortness of breath,

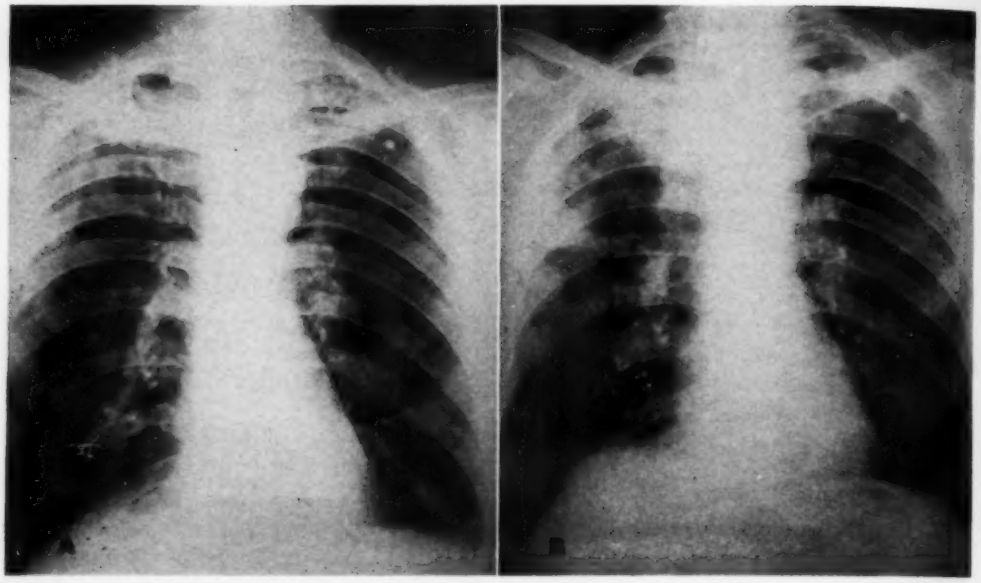


Fig. 2. Case II. Postero-anterior roentgenograms of Nov. 24, 1941, and Nov. 27, 1942, showing, in addition to increased infiltration in the right upper lobe, the presence of paratracheal lymph node involvement. The tracheotomy tube is in place because of disease of the larynx.

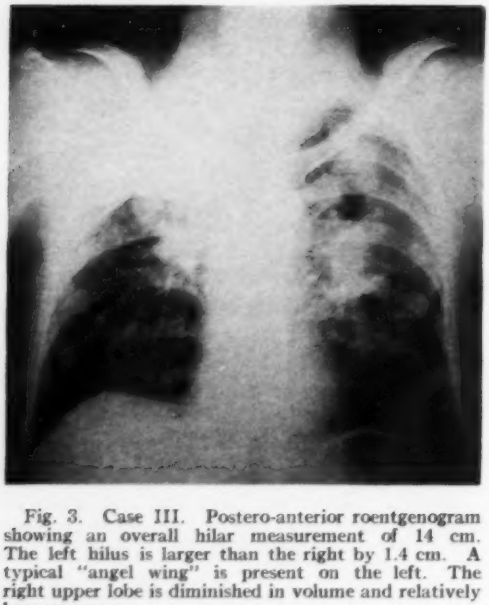


Fig. 3. Case III. Postero-anterior roentgenogram showing an overall hilar measurement of 14 cm. The left hilus is larger than the right by 1.4 cm. A typical "angel wing" is present on the left. The right upper lobe is diminished in volume and relatively homogeneous.

and a productive cough. Six months previously he had been hospitalized elsewhere for similar complaints, and bronchoscopy and bronchography had been done. Sputum studies revealed the presence of tubercle bacilli and the patient was thus admitted to Lowman Pavilion of Cleveland City Hospital for treatment of pulmonary tuberculosis. Bronchoscopy was repeated and was reported as showing tuberculous bronchitis. However, no biopsy was obtained. A right pneumothorax was instituted and discarded because of adhesions. Review of the slides of the bronchoscopic biopsy at the other hospital revealed undifferentiated carcinoma. On supportive therapy, the patient's condition gradually declined and he died on July 31, 1939. Autopsy revealed undifferentiated carcinoma of the right main stem bronchus with extension to the lower lobe, as well as ulcerative pulmonary tuberculosis of the right lung.

The radiographic finding which suggests the carcinomatous element is the homogeneous density in the lower lung field. Thus two features, the character of the lesion (homogeneity) and its location (lower lung field), indicate the need of studies to exclude associated carcinoma.

CASE II (Fig. 2): J.P., a 52-year-old white male, noticed a productive cough in January 1940. This persisted to June 1940, when hoarseness appeared. There was a weight loss of 11 pounds, and night sweats and weakness developed. It was believed that the patient had laryngeal and pulmonary tuberculosis. Cervical lymph nodes then became pal-

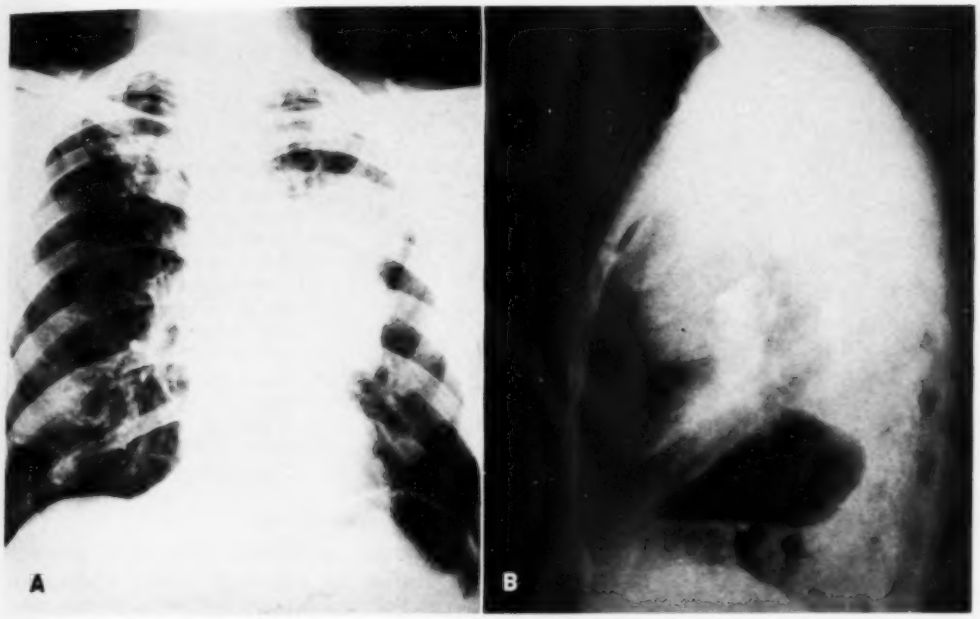



Fig. 4. Case IV. Postero-anterior and left lateral views showing mottled and linear infiltrations superior to the upper pole of the right hilus. There is a lobulated "mass" contiguous with the left hilus, presenting mainly in the upper lobe.

pable and were subsequently biopsied, revealing squamous-cell carcinoma. The patient's condition became worse and he died on Jan. 20, 1943. The pathological diagnoses included pulmonary tuberculosis, partially undifferentiated bronchogenic carcinoma of the right upper lobe bronchus, and well differentiated squamous-cell carcinoma of the larynx. The right paratracheal density represented metastatic carcinoma to the paratracheal lymph nodes.

The radiographic feature suggesting concomitant carcinoma is the right paratracheal density, which represents metastatic tumor of the lymph nodes.

CASE III (Fig. 3): H.W., a 55-year-old white male, entered the hospital complaining of vomiting, anorexia, and abdominal pain. The work-up included chest and abdominal radiographs, the former of which were thought to indicate far advanced pulmonary tuberculosis. A large epigastric mass was felt. The two diagnoses considered most likely by the clinicians were (*a*) pulmonary tuberculosis with tabes mesenterica and (*b*) carcinoma of the bronchus with metastases to the liver and superimposed pulmonary tuberculosis and pneumoconiosis. Autopsy revealed bronchogenic carcinoma involving both major bronchi, with metastases to regional lymph nodes and liver, as well as active pulmonary tuberculosis and silicosis.

The possible clue to concomitant bronchogenic carcinoma in this instance is the homogeneous density of the right upper lobe, which is diminished in volume. This would be unusual for the conglomeration of silicosis with infection (tuberculosis). The overall diameter of the hili measured 14 cm. This measurement has not as yet been studied in uncomplicated cases of silicosis.

CASE IV (Fig. 4): H.M., a 55-year-old white male, entered the hospital with cough as the chief complaint. He had apparently been well until two years prior to admission, when he noted the onset of cough, productive of gray sputum. At that time he was hospitalized elsewhere and a lesion of the left bronchus was discovered but was deemed inoperable by the surgeons. The patient was then lost to follow-up. Prior to this admission, the sputum was reported positive for the tubercle bacillus by the County Clinic.

In the hospital, tubercle bacilli were again found in the sputum. After preliminary examination, including pulmonary function studies, a left pneumonectomy was done and a bronchogenic carcinoma was found to be present. The patient is now receiving radiotherapy as the tumor was not completely removed. Streptomycin and PAS are being admin-

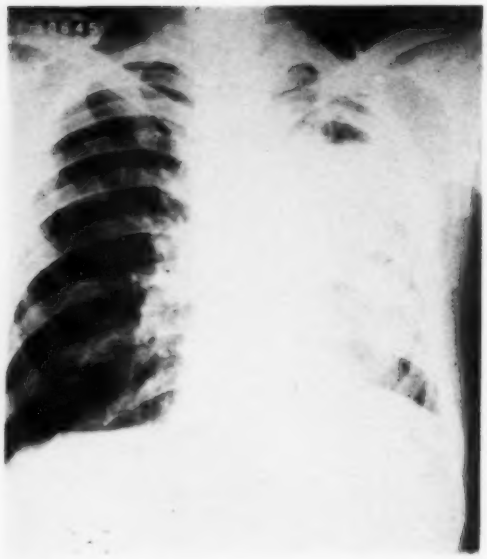


Fig. 5. Case V. Postero-anterior view showing linear and mottled densities in the right second anterior interspace. A dense homogeneous infiltration is seen in the left mid-lung field with a cavity at the first anterior interspace. Mottled and coalescent infiltration is seen in the left lower lung field.

istered for tuberculosis, which is assumed to involve the right lung.

The carcinomatous element is suggested by the enlarged left hilus and the contiguous mass.

CASE V (Fig. 5): J.E., a 53-year-old white male, was transferred to Lowman Pavilion from the surgical division of the hospital on Aug. 29, 1940, with a diagnosis of pulmonary tuberculosis on the basis of a positive sputum study. He gave a history of left chest pain of six weeks duration, weight loss, and a cough productive of small amounts of sputum. Physical examination revealed hard supraclavicular lymph nodes. Biopsy of one of these lymph nodes revealed "tumor" of indeterminate type. Clinically it was believed that the patient had metastatic carcinoma of the lymph nodes with the primary lesion in either the lung or pancreas. Death occurred on Oct. 20, 1940. Autopsy revealed squamous-cell carcinoma of the left upper lobe bronchus, with paratracheal and bronchopulmonary lymph node involvement and tuberculous bronchopneumonia, bilateral, with cavitation.

The carcinomatous element is possibly suggested by the large mass continuous with the left hilus. The tuberculous element is difficult to identify with certainty, though the infiltration on the right is suggestive.

CASE VI (Fig. 6): E.O., a 65-year-old white male, was admitted to the hospital on Dec. 31,

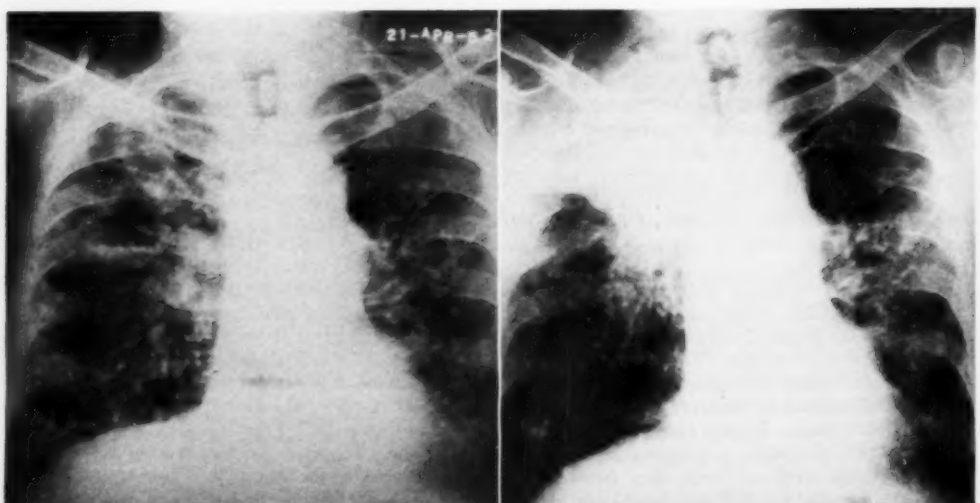
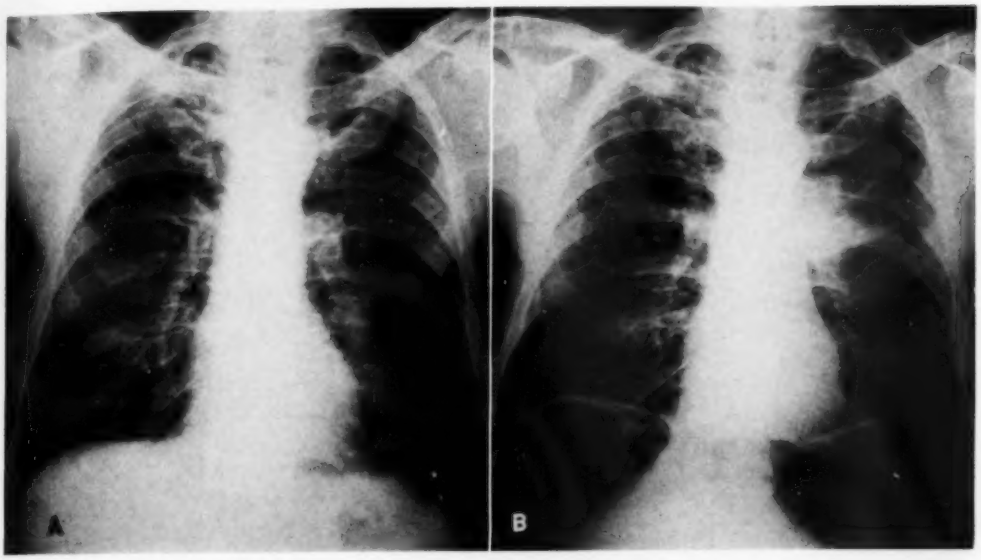


Fig. 6. Case VI. Postero-anterior roentgenograms April 21, 1952, and Jan. 5, 1954, showing bilateral infiltration, predominantly mottled in character, with cavitation in the right middle lung field. Subsequent diminution in volume of the right upper lobe is noted. Destruction of the posterolateral aspect of the right second posterior rib is also present.




1935, with cough, hemoptysis, anorexia, and weight loss. Sputum studies revealed tubercle bacilli on admission and occasionally during three years of hospitalization. Routine radiographs were taken, and in July 1953 a shadow of increased density was demonstrated in the right upper lobe and hilus, demanding additional studies. Bronchoscopy was done and biopsy revealed squamous-cell carcinoma. The patient refused surgery and was treated with high-voltage roentgen therapy. He died on April 17, 1954. Autopsy revealed squamous-cell carcinoma of the right upper lobe as well as fibrocaseous pulmonary tuberculosis, bilateral, with cavitation in the right upper lobe.

The carcinomatous element is suggested by the prominent right hilus, which measured 1.5 cm. more than the left, as well as by the homogeneous density in the right upper lobe, which is diminished in volume. To substantiate the diagnosis further, one notes destruction of the right second posterior rib.

CASE VII (Fig. 7): W.G., a 65-year-old male, had a survey film in August 1949 and was told that he had pulmonary tuberculosis. Several sputum examinations were positive for tubercle bacilli. A right phrenic crush and pneumoperitoneum were instituted on an ambulatory basis on Sept. 30, 1949. The patient was discharged to his home to await readmission if necessary. He did not return until April 12, 1951, when he complained of malaise, anorexia, and weight loss. Pneumonectomy revealed epidermoid carcinoma of the left lower lobe bronchus. It was assumed by the phthisiologists that the positive sputum was coming from the right upper lobe lesion.

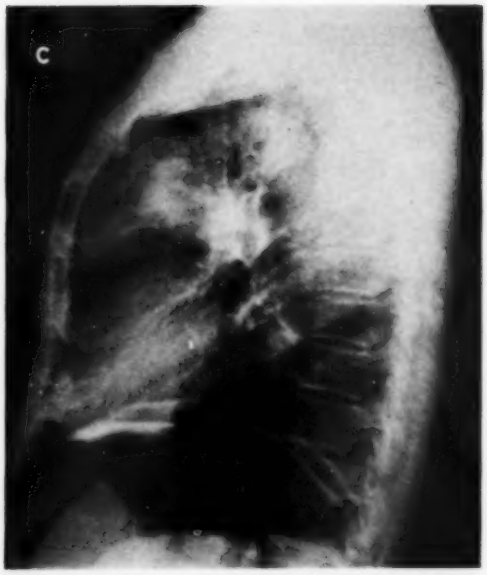



Fig. 7. Case VII. Postero-anterior and left lateral views from Aug. 3, 1949, to March 16, 1951, showing mottled and linear infiltration in the right apical and infraclavicular regions. Development of a left hilar mass extending into the left upper lobe is noted.

The carcinomatous element is suggested by the prominent left hilus, which meas-

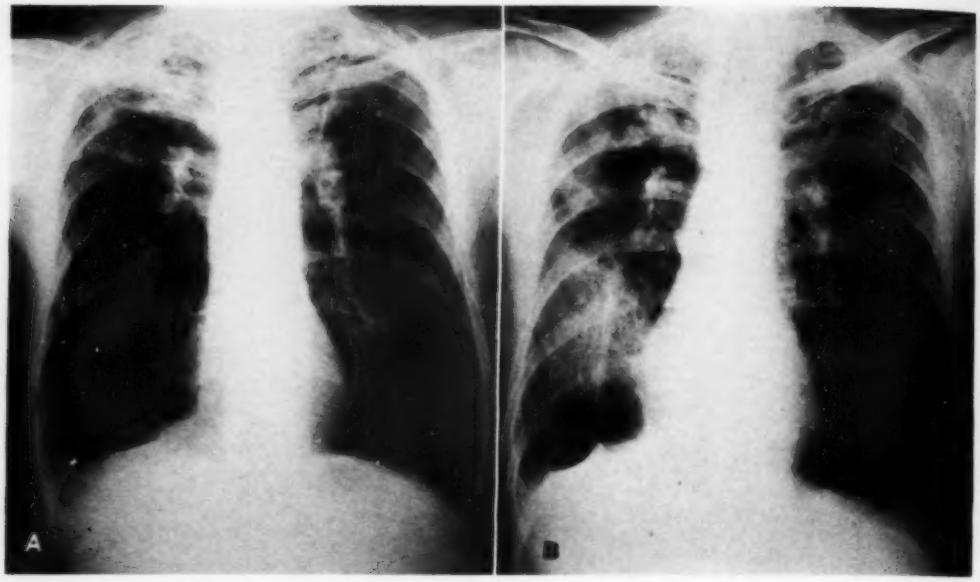


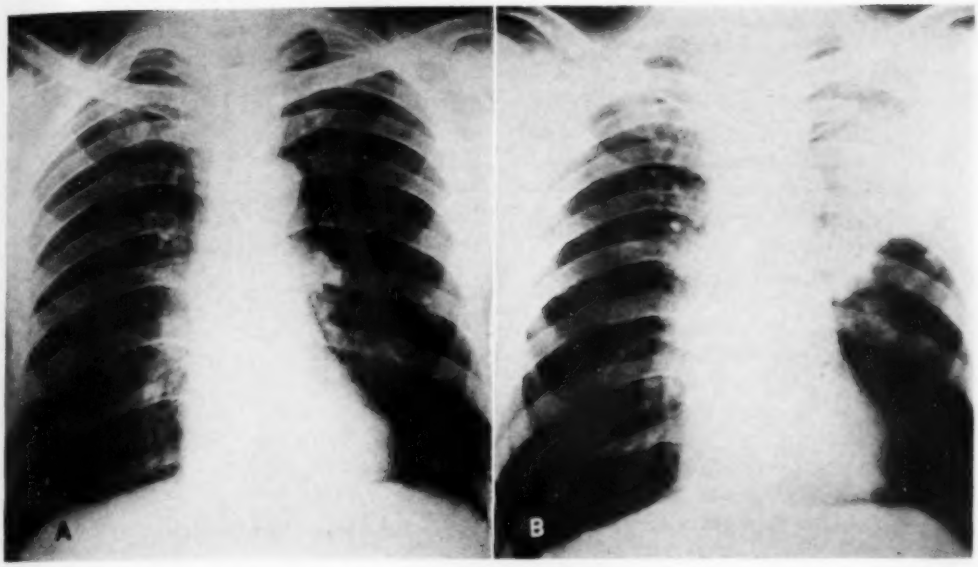
Fig. 8. Case VIII. Postero-anterior roentgenograms from March 22, 1949, to Feb. 3, 1953, showing the development of a homogeneous density in the right lower lung.

ured 2.7 cm. more than the right, though the overall diameter was slightly less than 13 cm.

CASE VIII (Fig. 8): P.H., a 67-year-old white male, was known to have chronic lung disease of ten years duration. Routine radiographs were obtained every six months through the County Clinic. On the last examination, he was told that there was suspicious activity. Sputum studies were done and tubercle bacilli were found. The patient was then admitted to Cleveland City Hospital for treatment of active pulmonary tuberculosis. He died after ten days, before any definitive therapy was instituted. Autopsy revealed bronchogenic squamous-cell carcinoma of the right middle lobe, as well as pulmonary tuberculosis.

The carcinomatous element is suggested by the relatively homogeneous density in the lower lung field, as well as the increasing size of the right hilus while the left remains unchanged. On the last examination, the right hilus measured 1.8 cm. more than the left.

CASE IX (Fig. 9): G.R., a 58-year-old colored male, was discharged from Sunny Acres Hospital on Jan. 16, 1951, with a diagnosis of minimal pulmonary tuberculosis, left infraclavicular. In September 1953, he was seen in the medical out-patient department because of weight loss, anorexia, and a productive cough with yellow sputum. He was admitted to the hospital, where bronchoscopy revealed "extrinsic pressure on the left main stem bronchus with bulging of the upper orifices of the left upper lobe." Before exploratory thoracotomy could be done, death occurred. Autopsy revealed squamous-cell carcinoma of the left upper lobe bronchus, as well as tuberculosis in the left upper lobe.



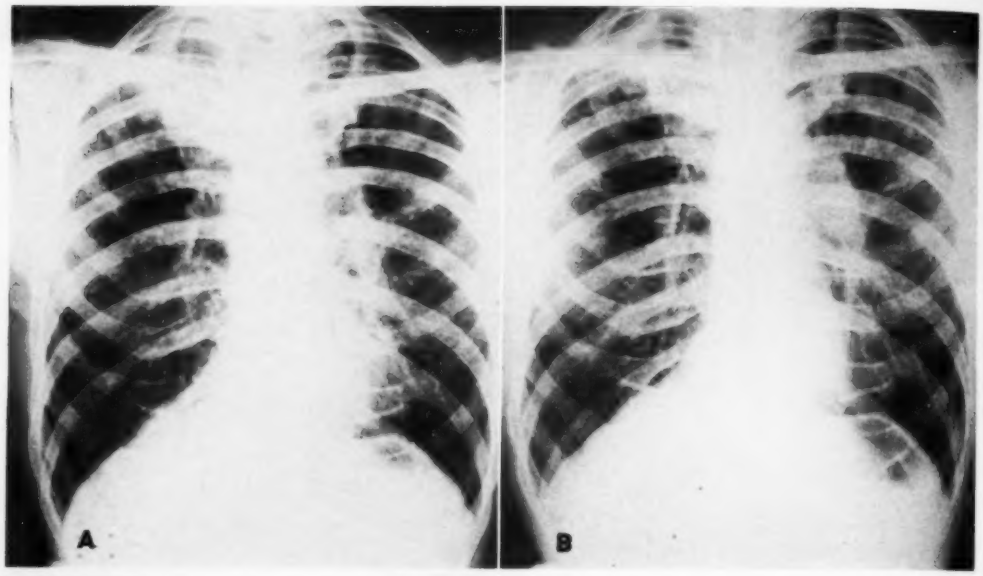

The carcinomatous element is suggested by the prominent left hilus, which measures 2.7 cm. more than the right. Also the density in the left upper lung is relatively homogeneous. In this case, the tuberculous element could not be recognized on the last radiograph.

CASE X (Fig. 10): E.R., a 55-year-old colored male, was admitted to Lowman Pavilion on Nov. 26, 1952. He had noticed the onset of weakness and fatigue one year previously. Shortly thereafter, a chronic cough developed, productive of 1 to 2 ounces of mucopurulent sputum. Numerous examinations of sputum revealed tubercle bacilli. Pneumoperitoneum was started, as well as antimicrobial therapy with streptomycin. Bronchoscopy six weeks previous to the patient's death showed "endobronchial disease of right upper lobe, right middle lobe and left lower lobe." The left upper lobe was grossly normal. The patient failed to respond to therapy and died Feb. 17, 1953. Autopsy revealed a bronchogenic carcinoma of the left upper lobe bronchus, as well as active pulmonary tuberculosis.

The carcinomatous element cannot be recognized with any degree of certainty. The rapidity of changes in the left lung in a two-month period might be somewhat unusual for uncomplicated tuberculosis. The measurements of the hili revealed a difference between them of less than 1 cm.

Fig. 9. Case IX. Postero-anterior and left lateral views from Dec. 4, 1950, to Sept. 18, 1953, showing the presence of coalescent mottled densities in the left second anterior interspace, with the subsequent development of a prominent left hilus and a contiguous "mass."

To study this problem further, a large group of unselected and consecutive cases of pulmonary tuberculosis was reviewed as a control series. Two hundred and fifty cases were studied in order to ascertain the frequency with which the aforementioned roentgen features of concomitant tuber-



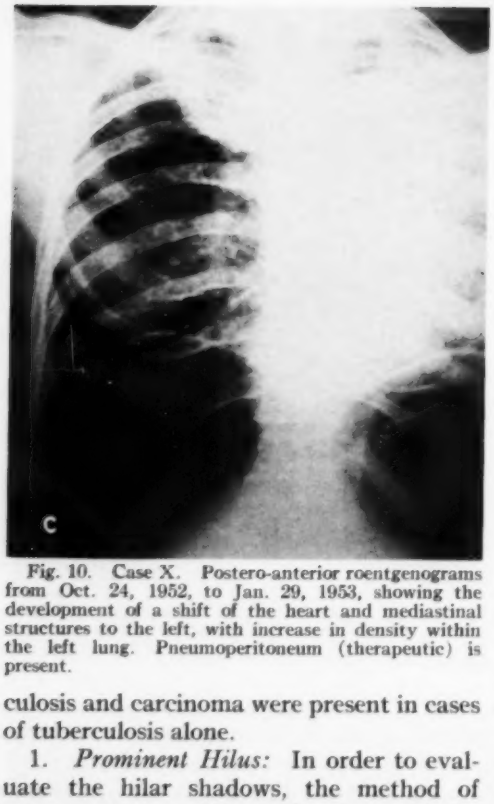




Fig. 10. Case X. Postero-anterior roentgenograms from Oct. 24, 1952, to Jan. 29, 1953, showing the development of a shift of the heart and mediastinal structures to the left, with increase in density within the left lung. Pneumoperitoneum (therapeutic) is present.

culosis and carcinoma were present in cases of tuberculosis alone.

1. *Prominent Hilus:* In order to evaluate the hilar shadows, the method of measurement advocated by Rigler, O'Loughlin, and Tucker (15) was used. These authors believe that 13 cm. as the overall length of both hili and 1 cm. as the difference between the two sides is the dividing line between normality and abnormality; any value below these figures, on a statistical basis, would be in the normal range. They, as well as others, have emphasized the importance of unilateral enlargement of a hilus as a sign of possible bronchogenic carcinoma, pointing out that the numerical approach to the problem should serve merely as a rough guide to abnormality.

In the cases of tuberculosis reviewed, the difference in the size of the right and left hili was found to be less than 1 cm. in 73 per cent. In 20 per cent of the cases there was a difference between the two sides greater than 1.5 cm. In 11 per cent the difference exceeded 2 cm. The overall total length of both hili was less than 13 cm. in 91 per cent of the cases. In 72 per cent, the overall length was 12 cm. or less. From a numerical standpoint alone, the figures obtained in cases of uncomplicated tuberculosis would indicate that unilateral hilar enlargement of a slight degree does occur, if 1 cm. difference between the size of the two hili is considered as a critical level. On the other hand,

the overall total length of both hili compares well with the normal range as indicated by Rigler, O'Loughlin, and Tucker. Thus, the more critical value, to act as a rough guide to abnormality, would be the measurement of the total length of both hili. It would be fair to state that obvious unilateral hilar enlargement in cases of tuberculosis demands further investigation.

2. *Paratracheal Lymph Node Involvement.* In only 2 of 214 cases, or 0.9 per cent, in which the paratracheal area could be visualized adequately, was there evidence of lymph node enlargement without calcification. Thus, from a statistical point of view, this phenomenon is most unusual in uncomplicated tuberculosis.

3. *Character of Spread:* For the purpose of this study, spread of disease was identified by study of serial radiographs. In those cases where there was bilateral disease radiologically at the onset, spread was assumed to have occurred "to the opposite side" if the infiltration was in the characteristic middle third of the lung or if there was cavitation solely in the opposite lung. The important factor to be studied was the character of the infiltration, whether it was homogeneous, mottled, cavitative, or streaked. In 145 cases spread of disease was observed. In 138 (95 per cent) of the cases, the spread was not homogeneous, consisting of mottled densities, linear streaking, and cavitation. In the vast majority spread was manifested by mottling and linear streaking. The 7 cases showing the spread as a homogeneous density were non-lobar in distribution and mainly in the upper lung field.

4. *Atelectasis or Collapse of a Lobe:* The possibility of major bronchial obstruction was considered where there was evidence of diminution in volume of a lobe. Only those cases were included where there could be no question in the interpretation of this phenomenon. In 54 cases, there was evidence of diminution of volume of a lobe. In 51 of these, however, the lobe involved did not present a homogeneous density, but rather showed mottling, linear streaking or cavitation. In 1 of the 3 cases showing a "collapsed" lobe which was totally homogeneous in density, concomitant bronchogenic carcinoma of the lobe was later proved to be present. It is important to note also that in only 2 cases were the lower lobes involved in "collapse."

5. *Well Defined Circumscribed Soft-Tissue Densities:* For this study, well defined circumscribed soft-tissue densities 3 cm. or more in diameter were tabulated. There were 5 instances in 250 cases, or 2 per cent. In 3 of these instances, cavitation was noted later. In all 5 cases, the densities were in the upper lobes.

The study of the control group of 250 cases of pulmonary tuberculosis thus revealed the following:

1. Significant lymph node enlargement in uncomplicated cases of tuberculosis is unusual. Certainly a distinctive unilateral hilar prominence would be an exception rather than the rule. If measurement of the hili by the method of Rigler, O'Loughlin, and Tucker is undertaken, the group to be studied further is that in which overall hilar length exceeds 13 cm.

2. This study would indicate that paratracheal lymph node involvement in pulmonary tuberculosis is very unusual and, if present, should suggest the possibility of concomitant carcinoma. Clinical experience would indicate that active mediastinal nodal tuberculosis and active reinfection pulmonary tuberculosis seldom occur together. This has occasionally been noted, however, particularly in young Negroes.

3. Tuberculosis is characterized by the fact that its spread to the opposite lung is usually of a mottled character. Thus any spread which is homogeneous in density must be viewed as distinctly unusual, and carcinoma should be excluded. This is particularly true if the density is in the lower lobes. Acute non-tuberculous pneumonia and intrapulmonary hemorrhage may appear as homogeneous soft-tissue densities. These can be excluded by their

tendency to resolve in a short period of time.

4. The presence of circumscribed soft-tissue densities 3 cm. or more in diameter is unusual in uncomplicated tuberculosis. Thus when such a solitary density is present, bronchogenic carcinoma must be excluded. Again this is particularly true in lower lobe lesions.

## SUMMARY AND CONCLUSIONS

1. Ten cases of concomitant pulmonary tuberculosis and bronchogenic carcinoma are presented.

2. The roentgen features suggesting the carcinomatous element are discussed.

3. Two hundred and fifty consecutive unselected cases of pulmonary tuberculosis were reviewed with reference to the aforementioned roentgen features.

4. This study indicates that in patients with pulmonary tuberculosis the following roentgen findings should alert the radiologist and clinician to the possibility of concomitant lung carcinoma:

(*a*) Unilateral prominence of the hilus.

(*b*) A hilar measurement (overall length of both hili) exceeding 13 cm.

(*c*) Paratracheal lymph node enlargement.

(*d*) The presence of an atelectatic or collapsed lobe or segment, in which mottling, linear streaking and/or cavitation is not seen and the density is thus essentially homogeneous.

(*e*) A "spread of disease" in which the character of the infiltration is homogeneous, especially if it is in the lower lung fields.

(*f*) A nodular density greater than 3 cm. in diameter, especially if it is in the lower lung fields.

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## SUMARIO

### Coexistencia de Tuberculosis y Carcinoma del Pulmón

Versa este estudio sobre 10 casos de tuberculosis y carcinoma concomitantes del pulmón, con un estudio testigo de 250 casos de tuberculosis sin complicaciones.

Indica el estudio que, en los tuberculosos pulmonares, los siguientes hallazgos roentgenológicos deben poner sobre aviso al radiólogo y al clínico en cuanto a la posi-

bilidad de carcinoma pulmonar concomitante: (1) prominencia unilateral del hilio; (2) medición hiliar (longitud total de ambos hilios) superior a 13 cms.; (3) hipertrofia de los ganglios linfáticos paratraqueales; (4) presencia de un lóbulo o segmento atelectático o aplastado, en el que no se observan moteamiento, estrías lineales y/o cavernas, siendo su densidad así en conjunto homegénea; (5) "difusión de la enfermedad," en la que la naturaleza de la infiltración es homogénea, sobre todo si radica en los campos pulmonares inferiores; (6) densidad nodular de más de 3 cms. de diámetro, sobre todo si radica en los campos pulmonares inferiores.

# Planigraphy in the Differential Diagnosis of the Pulmonary Nodule

## With Particular Reference to the Notch Sign of Malignancy[1]

LEO G. RIGLER, M.D., and E. ROBERT HEITZMAN, M.D.[2]

THE DETECTION of nodular lesions in the periphery of the lung by roentgen examination is now a common occurrence. Lesions as small as 3 mm. in diameter can be found when in a favorable position, and primary bronchogenic carcinomas, as well as metastases, as small as this have been reported. The major problem involved in the consideration of such lesions is the differential diagnosis as to the nature of the process producing what is commonly designated as a "coin" lesion. It has been estimated by some authors (2, 6, 12, 16) that there may be as many as thirty different causes responsible for the production of such a shadow.

In 1948, one of us (L. G. R.) first observed a curious irregularity or, as it was then called, an umbilication, on the margin of a shadow in a lateral roentgenogram of the lung, in a case later proved to be undifferentiated carcinoma. The repeated observation of a similar finding in planigraphic studies of spheroidal nodules in the lung, which later proved to be malignant tumors, has led to a more extensive study and to a preliminary report of this finding as indicative of malignancy (14).

With this particular sign in mind, we have reviewed all our cases of pulmonary disease found during the past five years in which planigraphic studies were made. Our object was to determine the value of such studies in the differential diagnosis of the peripheral lung nodule and to evaluate the significance of this "notch" sign in the diagnosis of pulmonary carcinoma. There were available to us some 550 cases in which lesions in the lung were suspected and more or less adequate planigraphic studies had been undertaken. Many of the studies proved to be insignificant; others were made for clear-cut tuberculosis and for similar reasons. We were able, however, to find some 132 cases in which planigrams were made to determine more clearly the nature of a peripheral nodule. In order to define the cases considered, we would clarify the term "peripheral nodule." As used by us, it refers to what is commonly miscalled a "coin" shadow but actually represents a spheroidal nodule in the lung. Cases have been selected in which a density can be seen in the lung almost completely surrounded by air, so that it is clearly not a part of the mediastinal structures or the major bronchi and has a general, although not necessarily clear-cut, spheroidal form. The size has varied from 1 to 10 cm. in diameter.

In 50 of the 132 cases the diagnosis was verified histologically. Of the proved cases, 24 were primary carcinomas of the lung and 8 metastases from various sources. There were 11 granulomas and 4 hamartomas. In 1 case the histologic evidence did not establish the diagnosis; in 2, exceedingly small lesions were actually not found at autopsy although the examination was not intensive enough to exclude them. In 3 cases bacteriologic evidence of the granulomatous nature of the lesion was clearly delineated. In 15 cases the malignant nature of the lesion was plainly apparent from the eventual course and various clinical findings which made the diagnosis unequivocal.

Among the malignant tumors which were

[1] From the Department of Radiology, University of Minnesota Medical School, Minneapolis, Minn. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

This study was supported in part by an American Cancer Society Institutional Grant.

[2] Fellow of the American Cancer Society.

removed so that they could be measured at the time of operation, 28 were more than 2.5 cm. in diameter, only 4 being less than 2.5 cm. We have seen roentgenograms of many cases in which the lesion measured much less than 2.5 cm., but unfortunately the original examinations were made in other institutions and body-section roentgenography had not been undertaken, so that it was impossible to study them from this point of view. It is regrettable that in so many of our cases the tumors were of the larger size, since the findings do not afford a clear indication of the possibilities of distinguishing the malignant nature of very small lesions. In the total group there were 29 cases in which we could demonstrate calcium with great certainty. In 9 additional cases calcification seemed to be present but was equivocal. In many instances histologic evidence could not be obtained, since the lesion was considered to be benign and it was not operated upon, but the follow-up study was of such a character as to indicate without much doubt its true nature.

A review of the literature concerning such shadows as are being discussed here indicates the large number of causative factors which have been reported. Many investigators have reviewed the importance of such lesions and have tried to analyze their characteristics in an effort to determine whether the diagnosis of cancer could be made with some degree of certainty (Fink, 4; Sharp and Kinsella, 16). Good and his associates (6), for example, analyzed 156 cases of solitary lung masses from the point of view of size, location in the lung, shape, sharpness of border, density, homogeneity of the shadow. The presence of calcification as opposed to a diagnosis of cancer and the evidence of growth as a positive sign were of value. Fink, likewise, found no cases of carcinoma in which calcification was present and felt that this was a useful negative sign. Sharp and Kinsella concluded that the only absolute diagnosis possible is by means of a microscopic examination of tissue removed at thoracotomy. They do, however, emphasize the importance of the demonstration of calcium, of cavitation, and of growth through repeated examination, but they doubt that either the presence of calcium or a lack of growth can be used to exclude carcinoma. Many other authors conclude studies of this kind with the admonition that all such peripheral nodular lesions should be removed, since the only manner in which their benign or malignant character can be determined definitely is by microscopic examination of the tissue.

But the removal of peripheral lesions found in the lung on roentgen examination places a very grave responsibility upon those advocating it. With the increased use of routine examination of the chest, many more peripheral lung densities are being discovered. The proposal to do a thoracotomy in an apparently well individual for a small shadow in the lung, without other evidence to indicate its serious character, is often not accepted by the patient and is difficult indeed for the physician to recommend unreservedly. For such reasons, it seems important to attempt to devise means whereby a more certain differential can be made.

The use of body-section roentgenography or, as it will be called hereafter in this paper, planigraphy, for the delineation of carcinoma of the lung has been reported by many observers. Rigler and Merner (15) found planigraphy of value in the demonstration of bronchial stenosis and bronchial tumors, comparing it favorably with bronchography and bronchoscopy. Moore (11), Hartley (7), Lodin (9), Andrews and Turek (1), Dreyer (3), Frimann-Dahl (5), and a great many other authors have likewise studied the use of planigraphy in the demonstration of bronchial obstruction in relationship to carcinoma of the lung. Lowry and Rigler (10) reported the use of planigraphy in the diagnosis of bronchial adenoma.

There have been, in addition, a number of previous studies on the use of planigraphy for the diagnosis of peripheral

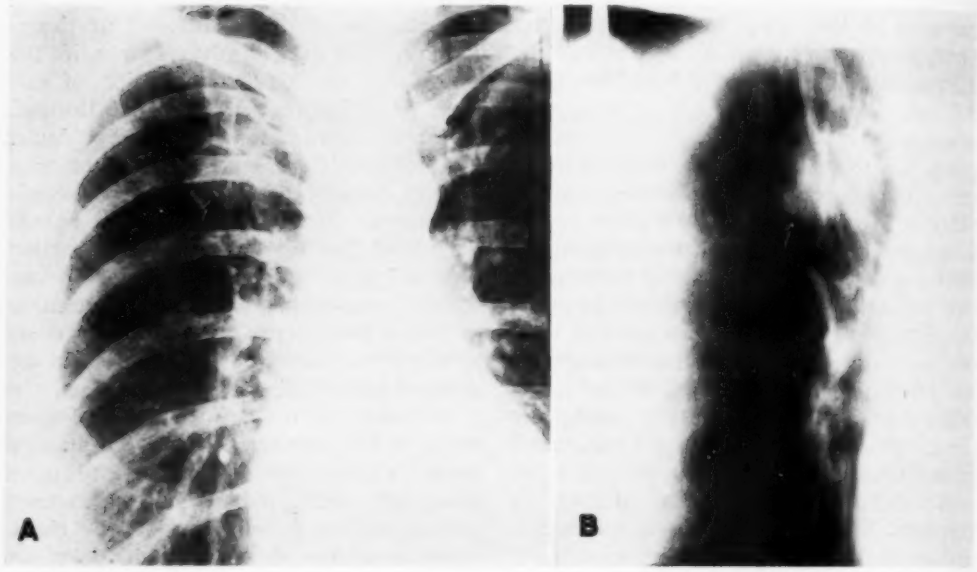


Fig. 1. Carcinoma of the right upper lobe, showing the advantages of planigraphy in delineating nodular lesions in the lungs.
A. Conventional roentgenogram. Infiltrative process in the right upper lobe (arrow) can be made out but is poorly defined.
B. Planigram of same area showing dense nodular lesion (arrow); size, shape, and outline are well shown. Note irregularity of margins and drainage toward the hilus.

nodular lesions. Sharp and Kinsella called attention to the value of planigraphy in the demonstration of cavitation and calcification. Oger and Loisance (13), Good, *et al.*, and Kane (8) have all emphasized the importance of the procedure for differential diagnosis. It is interesting to observe that one author, Storey (17), feels that planigraphy has not helped him in any appreciable degree in the diagnosis of peripheral nodular lesions.

A review of previous papers on the subject, especially those of Thornton (18), Umiker and Storey (19), and O'Brien *et al.* (12), reveals reproductions of planigrams in which there are exhibited solitary shadows showing the characteristic notching mentioned above, which will be described here. But the sign itself was not pointed out by the authors. The lesion proved to be carcinoma in all of the cases with one exception, a case of tuberculosis reported by Thornton, in which the sign seemed to be definite. In the monograph on planigraphy by Kane (8), three roentgenograms are reproduced which show this notching, and in all cases the lesions were found to be malignant.

In general, the literature on the subject of pulmonary carcinoma indicates that in numerous circumstances planigraphic studies of peripheral lung nodules may be of the greatest importance. In addition to calcification and cavitation, the form, exact size and exact position of a lesion, and the presence of contiguous small lesions can be determined with much greater accuracy than in the ordinary roentgenogram (Fig. 1). Despite such advances in the demonstration of the pathological anatomy of nodules, the ability to distinguish cancer from granulomas and benign tumors has not been greatly improved.

## RESULT OF PRESENT STUDY

We investigated the planigraphic findings in our series of cases for many criteria, such as size, shape, location, etc., to de-

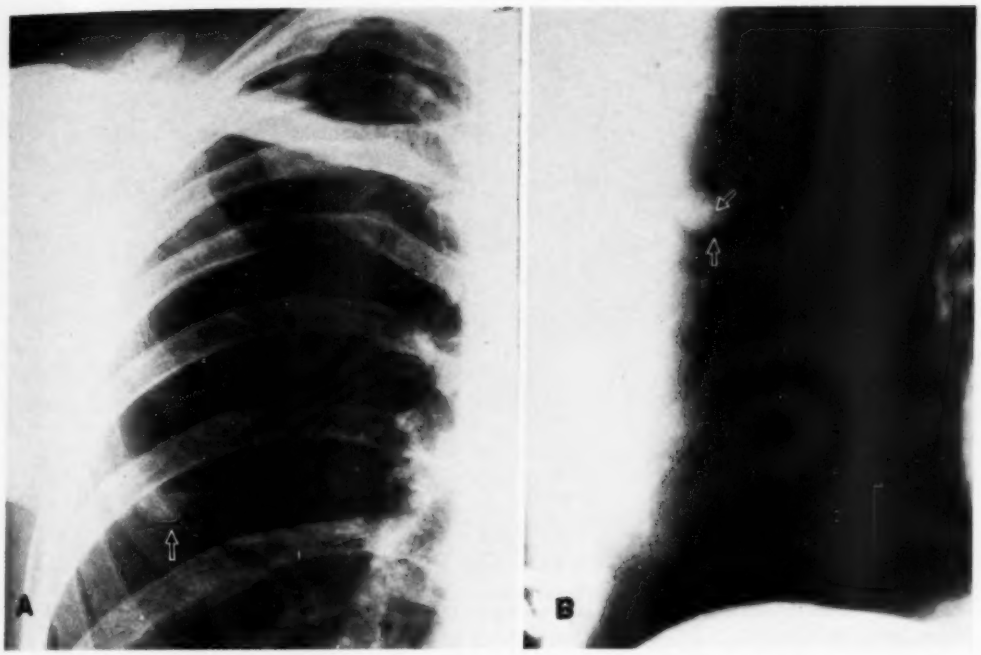


Fig. 2. Case I. Nodular lesion in the lung appearing at age fifty-three, not previously present.
A. Conventional roentgenogram showing nodule (arrow).
B. Planigram demonstrating sharp outlines (arrow) and small punctate area of calcification (arrow). This proved to be a calcifying tuberculoma.

termine whether such observations would be of value. We found finally that calcification, cavitation, and the notch or umbilication sign previously referred to were the only signs of any real significance.

The importance of *calcification* as indicating a benign lesion was clearly illustrated in the following case.

CASE I: A 50-year-old woman consulted her physician because of a gynecological condition. She had no pulmonary symptoms. Routine examination of the chest revealed a small nodule in the right upper lobe (Fig. 2A). Upon further investigation, it was found that an x-ray examination had been done approximately four years before. Review of this film revealed no evidence of the nodule. Because of this, it was considered likely that it might be a carcinoma of the lung. Planigraphic study was done. Although no calcium whatever could be made out in the original films, definite calcification within the nodule, of a somewhat pin-point type, was observed (Fig. 2B). Because of this, a diagnosis of granuloma was made. Despite this finding, the clinicians insisted upon surgery and the nodule was excised. It proved to be a tuberculoma, fairly well healed.

*Comment:* This case illustrates the importance of demonstrating effectively the presence of calcium. It is possible that the surgical procedure in this instance was not absolutely necessary; it was undertaken largely because of the strong impression created by the sudden appearance of a nodule in the lung in a fifty-year-old woman. In our experience, the demonstration of calcium in the lesion has been uniformly indicative of its non-malignant nature.

The results of our study on the significance of calcification are similar to those of other investigators. Of the 29 cases in which the planigrams showed definite calcification and in the 9 in which it appeared to be somewhat equivocal, there was not one in which a malignant growth was found. On the other hand, in the 34 cases of microscopically proved cancer in this series, not one showed calcification. It is our considered opinion, therefore, that the presence of calcification, despite

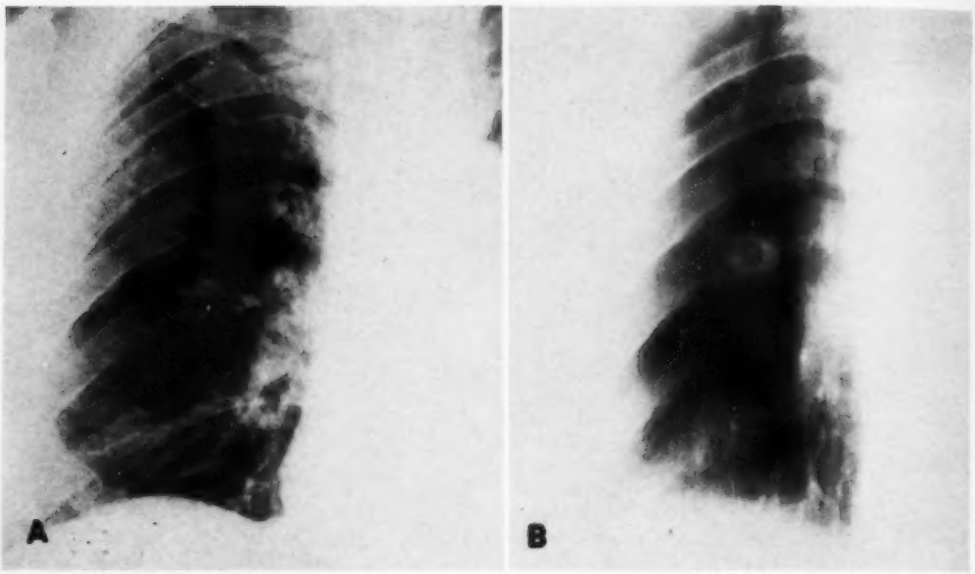


Fig. 3. Case II. Cavitating carcinoma of lung, illustrating value of planigraphy.
A. Conventional roentgenogram showing infiltrating process in the lung (arrow) with very questionable cavity within it.
B. Planigram obtained at the same time, showing round cavity with thick wall (arrow), fairly characteristic of carcinomatous lesion.

some startling exceptions, is the best evidence, aside from the microscopic examination, of the non-malignant character of a lesion.

*Cavitation* was found in 18 of the 132 cases. In many of these the cavitation could not be clearly delineated on the roentgenogram. The following is a case in point.

CASE II: A 72-year-old man was first seen because of right upper quadrant pain. A routine photofluorogram of the chest revealed an infiltrative process in the right lung. Because of the x-ray finding, he was admitted to the hospital for observation. He had experienced some weight loss recently, but had no specific chest complaints. There was a history of an episode of fever four months previously, considered to be pneumonia, from which he had promptly recovered.

Diagnostic studies, including bronchoscopy, bronchography, and examinations of the sputum for abnormal cells were completely negative.

Conventional roentgen examination of the chest (Fig. 3A) confirmed the photofluorographic finding of an infiltrative process in the middle of the right lung. Planigraphic studies (Fig. 3B) were then done and indicated the presence of a cavity with a thick wall within the abnormal shadow. Despite the suggestion that this might well be a carcinoma, a course of six weeks observation under antibiotic therapy was undertaken, largely because of the lack of other confirmatory findings. There was no change in the appearance of the lesion.

At this time a thoracotomy was done and a neoplasm, which had already spread to the peribronchial lymph nodes, was found. On histological examination it proved to be an alveolar-cell or bronchiolar carcinoma.

*Comment:* The cavitation was far better demonstrated in this case by planigraphy than could be ascertained in the ordinary examination. The history of pneumonia with the appearance of an abscess in the lung four months thereafter is, of course, confusing. This case emphasizes the dictum that an abscess without a clear-cut etiologic basis, especially if it occurs in a male over the age of forty-five, should be regarded as carcinomatous until proved otherwise.

Of the 18 cases with cavitation, only 13 were finally proved unequivocally. Eleven of these proved to be malignant, while 2 were granulomas. The other 5 patients were either not operated upon or failed to return, so that there was insuffi-

cient follow-up for a definite statement. It is evident, however, even from this small group, that the presence of cavitation in a lesion which shows no other evidences of an inflammatory process should certainly be considered as indicating a malignant tumor and treated accordingly.

Fig. 4. Notch sign as shown by planigraphy. Planigram of large squamous-cell carcinoma with cavitation. The indentation of the inferior wall (arrow) is well shown and is fairly characteristic of the notch commonly seen in malignant nodules.

*The Notch Sign:* In the entire series, as *reported above*, the observation of an irregular indentation of the margin of the shadow of the lesion best seen in planigrams (Fig. 4), but occasionally demonstrated also on conventional roentgenograms (Fig. 5), was studied. The importance of the demonstration of a notch by planigraphy is well illustrated by the following case.

CASE III: A male, aged 63, was sent in for evaluation because of a tentative diagnosis of tuberculosis in the right upper lobe. He gave a history of chest pain for one year and a mild cough productive of thick sputum for eight months. The sputum and gastric washings were negative for tubercle bacilli. Bronchial washings were negative for tumor cells. Bronchoscopy was negative. A conventional roentgenogram (Fig. 6A) showed a large nodular mass,

Fig. 5. Notch sign in a conventional roentgenogram. Squamous-cell carcinoma showing nodular density with notch sign on superior border (arrow).

subpleural, in the right upper lobe, with extensive infiltration about it. A planigram (Fig. 6B) exhibited a typical notch on the lower border (arrow), indicating carcinoma. Thoracotomy was done, and an alveolar-cell (bronchiolar) carcinoma was found attached to the pleura but without lymph-node involvement. Lobectomy was extremely difficult. The patient also had a severely bleeding duodenal ulcer, and the combination of events resulted in his demise five weeks after surgery. At autopsy no recurrence of the tumor was found and there was no evidence of lymph node involvement.

The findings were doubtful in this case, since the roentgen signs were not characteristic and all other evidences of tumor were lacking. The planigraphic demonstration of the notch sign was the major factor in the decision to explore the thorax.

## DISCUSSION

The cases reviewed were divided into two groups. One comprised those showing a definite notch. The second included those in which, in the present state of our knowledge, the notch sign should be considered equivocal. It should be noted that the films were examined by both of the writers independently of each other and with no previous knowledge whatever of the history, final outcome, or previous roentgen diagnosis, in order to get as unprejudiced a picture of the significance of this notch as was possible. It should be

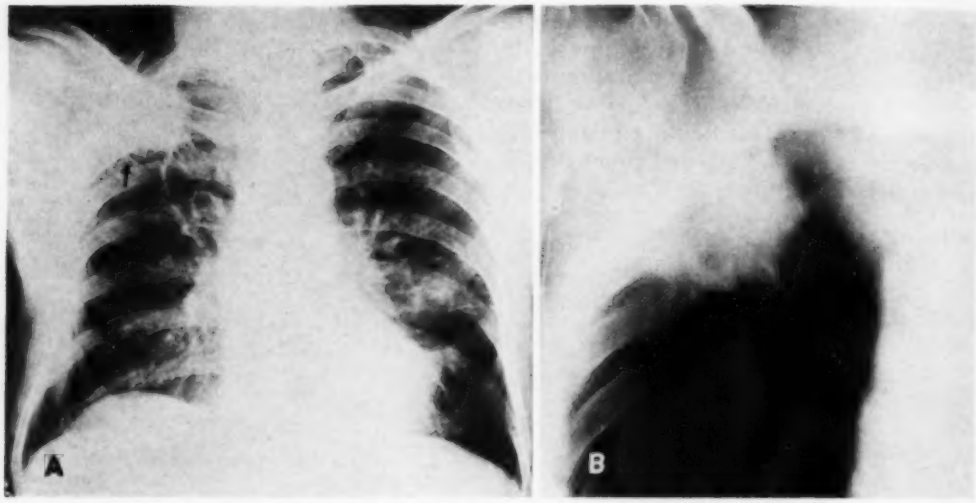


Fig. 6. Case III. Alveolar-cell carcinoma of lung showing notch sign in planigram.
A. Conventional roentgenogram. Mass in right upper lobe (arrow) with diffuse infiltration and drainage shadows extending toward hilus.
B. Planigram showing notch on inferior border (arrow) indicating carcinomatous nature of process.

noted, also, that the notches are not always as clear-cut as they might be. Even in planigraphic studies the superimposition of blood vessels or of other structures may lead to the appearance of a notch or indentation when, in fact, this is not within the lesion itself. Such an example is shown in Fig. 7A, a case of metastasis from melanoma. The notch sign here is equivocal. Furthermore, obviously lobulated masses which are the result of the coalescence of several tumors may give an irregularity simulating a notch. We attempted to eliminate all such factors.

In the series we found 25 cases in which a definite notch could be determined and 11 cases in which the notch sign was suggestive but which we considered equivocal. Among the 25 definite notch signs, 20 were seen in shadows measuring more than 2.5 cm., 5 in smaller shadows. Of the 20 larger lesions, 13 were proved by histologic evidence to be malignant tumors of various kinds, both metastatic and primary. In 5 others the presence of cancer elsewhere and of nodules in other parts of the lung, or the course of the disease, was so strongly in favor of a metastatic lesion that the probabilities are extremely high that these cases, too, were malignant. In 2 instances no diagnosis could be arrived at, since the patients were not operated upon and were lost so that their actual course was not finally determined. In no case in this group of lesions larger than 2.5 cm., in which there was a definite notch, was there ever any evidence that the lesion was other than cancer, although, as stated above, in 2 cases the diagnosis was certainly not clearly established. Of the 5 cases in which the lesion measured less than 2.5 cm., 2 were proved to be malignant on a histologic basis and 2 on the basis previously discussed, so that the probabilities are extremely strong that 4 out of 5 of these were also malignant. In 1, however, not histologically proved, old films indicated that a small lesion less than 1 cm. in diameter had been present unchanged for a period of eleven years. This no doubt was benign. Thus there was one distinctive error in the group of cases in which the lesion was small and in which there was apparently a definite notch.

A very different situation obtained in the so-called equivocal notches. Six of the lesions in this group were greater than 2 5 cm. in diameter, and 4 of these were

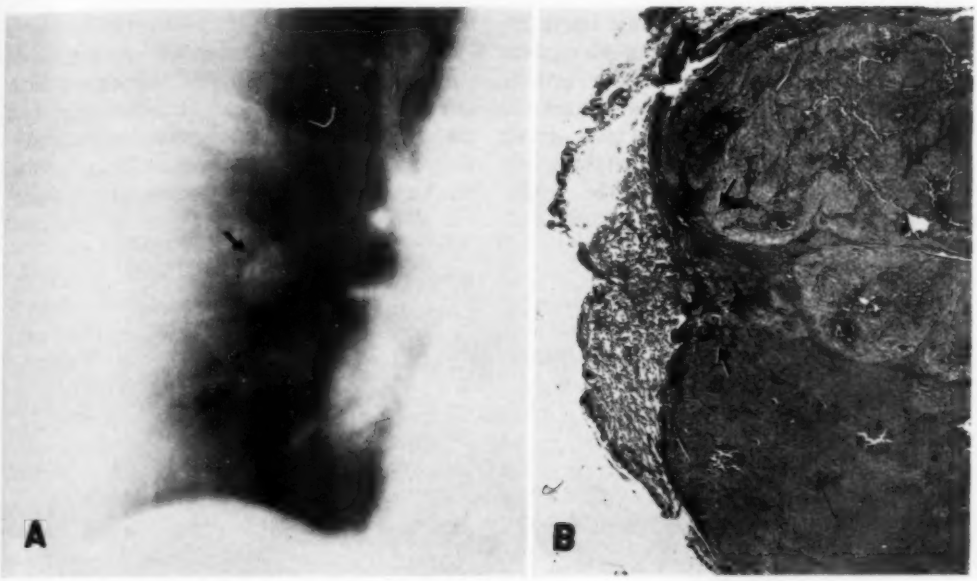


Fig. 7. Equivocal notch sign in a case of metastasis from melanoma.
A. Planigram showing the nodule in the lung with very slight indentation (arrow), which we consider to be an equivocal or doubtful notch sign.
B. Part of microscopic section from this nodule showing the origin of the notch (arrows). Lung tissue and vessels produce an indentation in the margin of the tumor which is lower in radiability than that of the tumor.

proved histologically to be malignant. In 1 other the suspicion of malignancy was so strong that it seems reasonable to suppose that it, too, was of this character. One case proved to be a hamartoma and, therefore, constitutes an error. In the 5 lesions less than 2.5 cm. in diameter, 1 proved to be malignant, 2 were granulomas, and 1 a hamartoma; 1 was lost to follow-up. It is evident from this that the observation of a notch in a very small lesion, if it is not perfectly clear-cut, is of little or no value.

Of the 32 malignant growths proved histologically, 15 showed a definite notch sign and 5 a more equivocal one, while in the remaining 15 it was not demonstrated.

It should be noted that this sign is present in metastases as well as in primary carcinoma of the lung. Since in most instances it has been observed in solitary lesions, this is not a serious disability, as the importance of the demonstration of the sign lies in the indication which it affords for immediate surgery. Certainly in many cases a solitary metastasis is a clear-cut indication for extirpation and therefore, if there is any doubt, the presence of this additional evidence might prove a further stimulus to surgical exploration.

The absence of the notch sign is of little or no significance in the determination of the malignancy of a peripheral lung nodule. It is apparent that the notch, which may represent a sort of hilus extending in on one surface, could be on any one of the many surfaces exhibited by a spheroidal nodule. As a result, it would be necessary to make planigraphic studies not only in the postero-anterior and lateral projections, but also in the oblique projections, to make certain of finding the actual area of invagination when it is present. Since this is not entirely practical, it must be assumed that the absence of notching is of no real significance.

We have made some attempts to determine what the origin of this indentation is on an anatomico-pathologic basis, but our efforts have not yet been attended with

much success. Attempts to trace back the sections removed from the lung specimens in the cases found to have this notch, in our review, were notably unsuccessful. Usually the sections available were small and did not comprise a sufficient segment of the tumor to be reliable. In many cases the tumor was badly mangled in the course of its removal. As a result, we have little to report in this respect. Two cases, however, have been studied carefully enough and with good enough sections to give some notion of the nature of the process. One of these was a metastatic melanoma of very small size, well under 2.5 cm., which showed an equivocal notch in the roentgenogram (Fig. 7A). The histologic section of this small lesion (Fig. 7B) shows an area of blood vessels surrounded by alveoli which is drawn into one side of the tumor. It is possible that the tumor has grown around this stalk, thus resembling the hilus of an organ. In the other case, a metastatic hypernephroma of considerably larger size with a very distinctive notch (Fig. 8A), the same sort of finding was obtained when the tumor was removed (Fig. 8B). A sort of crease within the tumor, when seen on end in the roentgenogram, would no doubt produce the notching or indentation described. Microscopically (Fig. 8C), at this point there were blood vessels with alveoli surrounding them. It is easy to see how

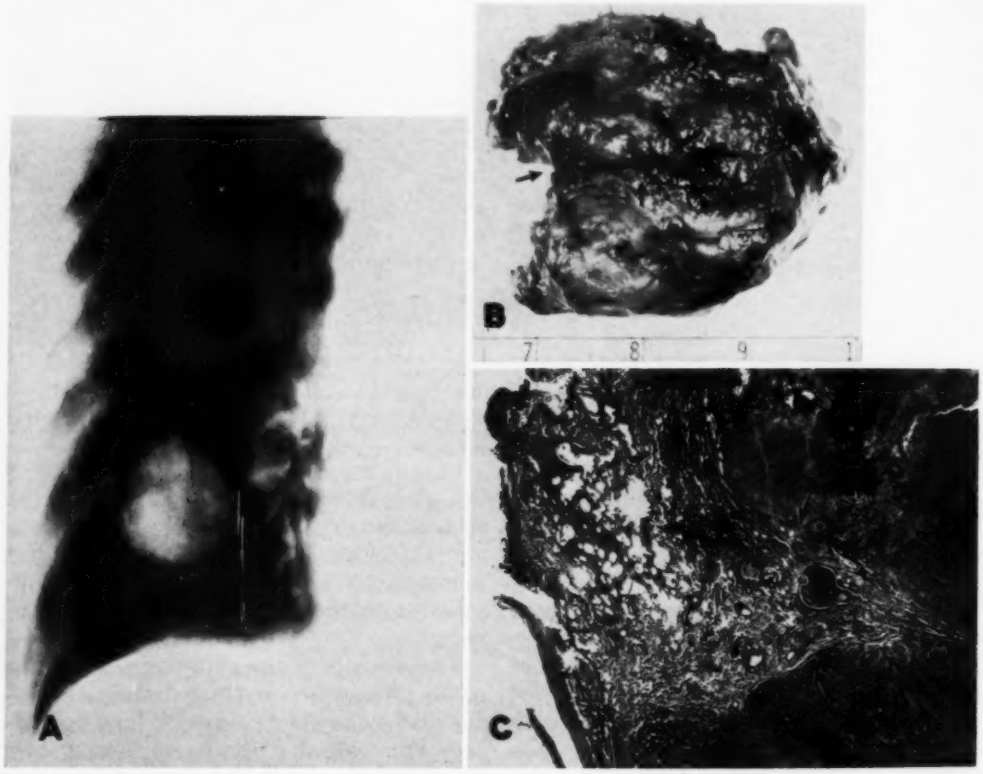


Fig. 8. Notch sign in a hypernephroma metastasis.
A. Planigram showing large nodule in lung with marked indentation on lateral border, fairly characteristic of notch sign.
B. Surgical specimen showing a deep groove (arrows) in the tumor corresponding to the notch.
C. Microscopic section showing alveoli and blood vessels extending into the margin of the tumor, causing an indentation which is much greater in radiability than the tumor itself, thus producing the notch sign.

this would produce a notch-like area of lesser density in the roentgenogram.

In a paper by O'Brien, *et al.* (12), reporting a lesion followed for a year as tuberculous and ultimately proved to be a bronchogenic carcinoma, a photograph of the gross specimen clearly shows the notch in one margin. No doubt pathologists have observed some such finding as this without being conscious of its significance.

Presently a study has been undertaken by means of reinflation of lobes removed at autopsy and at surgery, with injection of the vessels in a variety of ways, together with x-ray examination, to give a more definite indication as to the nature of this irregularity in a malignant tumor. The work is still in its beginnings and no results are available at this time.

We feel, however, that this is the first new evidence to be presented which will be of assistance in determination of the malignant nature of a peripheral spheroidal nodule in the lung. It is implicit that in any study of an individual, to determine whether or not exploratory thoracotomy should be undertaken, many considerations in addition to the x-ray findings must be entertained. But the presence of an additional sign which is as cogent as the one herein described may be sufficient to tip the balance in favor of exploratory operation when other considerations are inadequate to promote such a procedure. Certainly, before any surgical procedures are undertaken on a lung, every effort to determine the exact nature of the lesion should be exhausted. Among such efforts, planigraphy is, without doubt, one of the most important. The presence or absence of the three findings, calcification, cavitation, and the notch sign which we have just described, is most significant in so far as determining the benign or malignant character of the lesion.

## SUMMARY

1. The results of a study of the value of planigraphy in the differential diagnosis of the isolated spheroidal shadow in the lung are recorded; 132 cases exhibiting such nodules were reviewed.

2. Calcification in a nodule is best demonstrated by planigraphy and is a clear indication of the non-malignant character of the lesion.

3. Cavitation can frequently be clearly demonstrated by planigraphy when it is not clear in conventional films. It is strongly indicative of malignancy in this type of case.

4. A new roentgen sign, the notching or umbilication of a border of a spheroidal nodule is described. It is best demonstrated in body-section roentgenograms. When definite, it is highly indicative of malignancy, either primary or metastatic. When equivocal, especially in very small lesions, it is of little value. The absence of this sign is of no significance.

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SUMARIO

**La Planigrafía en el Diagnóstico Diferencial del Nódulo Pulmonar con Referencia Particular al Signo de la Escotadura en el Cáncer**

Preséntanse los resultados de un estudio de valor de la planigrafía en el diagnóstico diferencial de la sombra esferoidal aislada en el pulmón. Se repasan 132 casos que manifestaban esos nódulos.

La calcificación de un nódulo se descubre mejor con la planigrafía y constituye una indicación neta de la naturaleza no maligna de la lesión.

Con la planigrafía pueden descubrirse frecuentemente las cavernas cuando no aparecen con claridad en las radiografías corrientes. En este género de casos, indican poderosamente cáncer.

Descríbese un nuevo signo roentgenológico: la escotadura de la umbilicación de un borde de un nódulo esferoidal. Se observa mejor en las radiografías de segmentos del cuerpo. Cuando aparece bien definido, es sumamente indicativo de cáncer, ya primario o metastatico. Cuando es dudoso, sobre todo en lesiones muy pequeñas, posee poco valor. La ausencia de este signo carece de importancia.

# Isodose Curves for Superficial Therapy

E. DALE TROUT, B.S., Sc.D., JOHN P. KELLEY, B.S., ARTHUR C. LUCAS, B.S., and EDWARD J. FURNO, B.S.

ISODOSE CURVES for the low voltages and small fields used in superficial x-ray therapy have been the subject of few publications. Excellent central-axis depth-dose data are available as a result of work by Andrews and Braestrup, by Braestrup, and by Johns, Epp, and Fedoruk. In 1941, Lamerton published isodose curves for four widely used fields at a single half-value layer, and in 1943 Mayneord made available additional material at two lower voltages.

Having recently completed work on isodose curves for the small fields used in intracavitary therapy, the authors considered it worthwhile to explore the fields and radiation qualities usually associated with superficial therapy. It was thought that some significant information might be developed regarding the radiation at the edges of such fields and that this might be of value in correlating the size of the lesion and the size of field required for an adequate dose.

## INSTRUMENTS AND EQUIPMENT

In the study covering intracavitary fields, a modified Royal Cancer Hospital probe was used. This probe made use of an ionization chamber having a 1-mm. wall of air-equivalent material. It was felt that, for use with the low voltages and filtrations commonly associated with superficial therapy, a thinner wall would be advisable. Accordingly, the 1-mm. wall was reduced to a thickness of 0.28 mm. A check of the uniformity of the wall thickness was made by rotating the chamber in a low-voltage x-ray beam. The internal dimensions of the chamber were: length, 5 mm. and diameter, 3 mm., giving a volume of 0.035 c.c. after deduction of the volume of the central electrode.

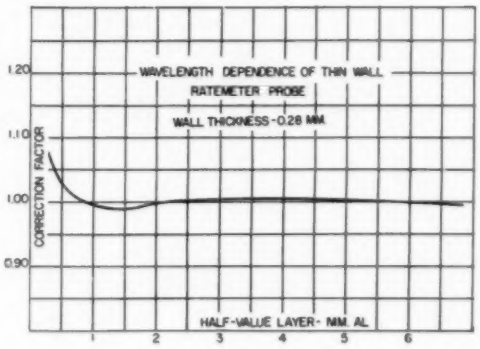


Figure 1

The chamber was calibrated against a 25-r Victoreen thimble chamber previously calibrated at the National Bureau of Standards. A plot of the wave-length dependence of the chamber is shown in Figure 1.

The question of the shadow cast by the metal stem of such a probe must always be considered for small fields at low voltages. This so-called "stem effect" may have an influence on both the surface dose and that at a depth. The effect that the metal stem of the Royal Cancer probe might have on our work was studied by placing the chamber 0.5 cm. below the surface of a phantom and, with the chamber as the axis, rotating through 360° a heavy lead diaphragm having a 5 × 2.5-mm. slot centered 1.75 cm. from the axis of rotation. The dose rate read by the chamber under such conditions would be due to radiation scattered into the chamber from the area irradiated through the slot, and any appreciable stem effect should show up in a polar plot of the ionization recorded by the chamber. It was found that in the area shaded by the stem there was an appreciable reduction of the ionization current. For this reason it

[1] Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

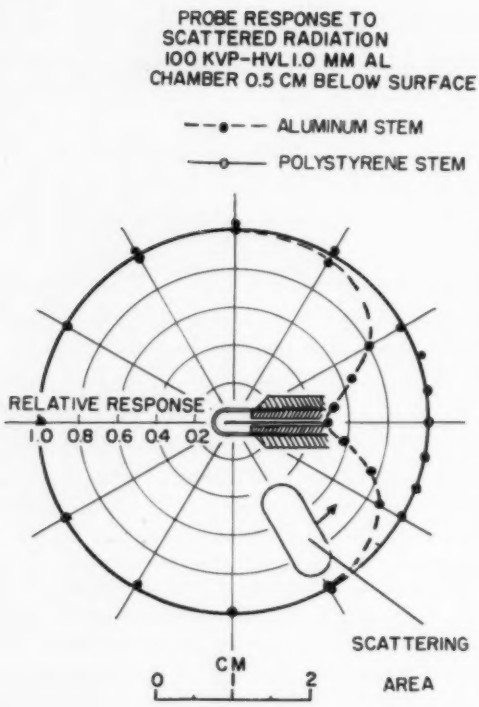


Figure 2

was felt advisable to modify the probe in order to remove so far as possible this stem effect.

The aluminum cylinder previously used for the stem was replaced by a polystyrene rod. Having a density essentially that of the phantom material, the stem would then become effectively a part of the phantom. The only stem effect would then be due to the electrodes necessary to connect the amplifier to the chamber. The central electrode was made of a piece of 0.019-inch aluminum tubing. The wall of the chamber was connected through a cylinder of aluminum foil 0.001 inch in thickness. The two electrodes were separated by polystyrene tubing with an outer cylinder of polystyrene to protect the aluminum foil. When this probe was subjected to the same treatment as the metal probe, the readings were essentially constant throughout the whole of the 360°. The method used for this experiment and the results are shown in Figure 2. A diagram of the modified probe is shown in Figure 3.

The probe was used in connection with a d.c. amplifier rate-meter described in a

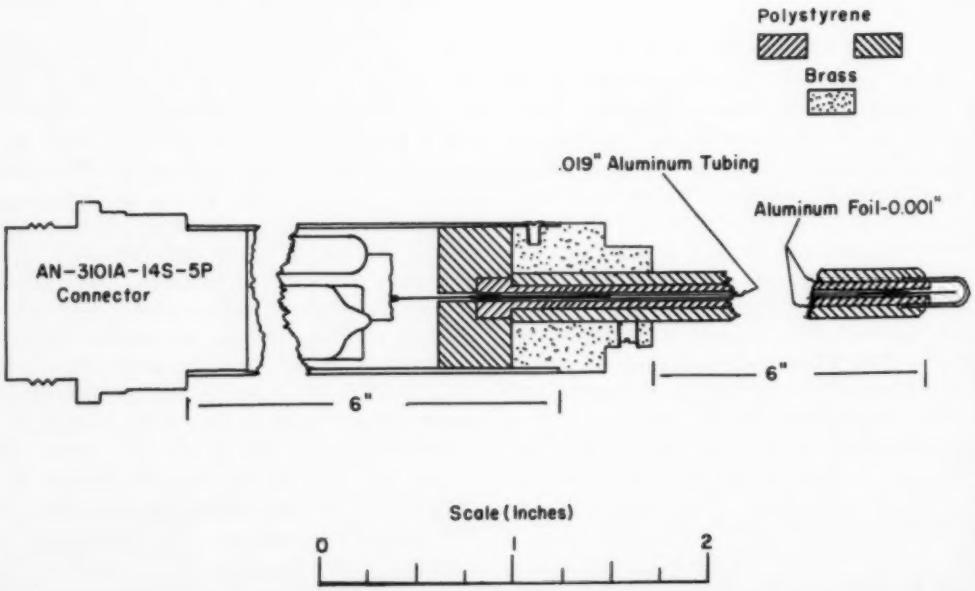


Figure 3. Diagram of probe assembly.

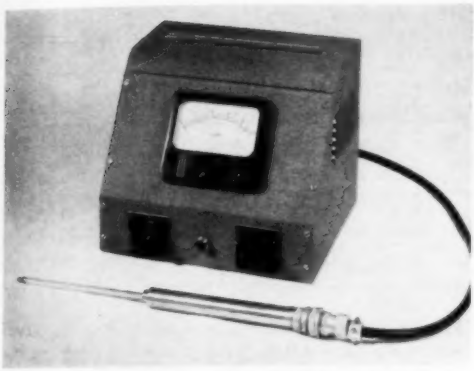

Fig. 4. Photograph of probe and rate meter.

previous paper (12). The probe and associated rate-meter are shown in Figure 4.

The phantom material used was that devised by Jones and Raine and commonly known as Mix-D. This material is a solid and is much easier to use than a water phantom. The phantom was 12 inches in all dimensions and thus should represent an infinite volume for the small fields and voltages under consideration. Data were taken by securing the chamber in the phantom and moving the phantom across the field rather than by moving the chamber in the phantom. The experimental set-up consisted of a motor-driven table on which the phantom was placed with remote Selsyn indicators to show the position of the chamber in the field at all times.

Field definition was provided by lead diaphragms 1/8 inch thick suspended just above the surface of the phantom. Some studies were made to determine whether there would be any significant difference in data obtained with a diaphragm of this type and observations made with the conventional superficial therapy cone. While there was some slight difference in the surface dose, due to the scattering from the walls of the cones, there was no essential difference in the central-axis depth dose or the shape of the isodose curve.

## TECHNICS

Studies were made for three distances in wide use for superficial therapy, namely, 15 cm., 21.5 cm., and 30 cm. Voltage and filtration were adjusted to give half-value layers of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, and 4.0 mm. aluminum and 0.5 mm. copper.

The voltages and filtrations used to arrive at these half-value layers were:

| Half-Value Layer | Kilovolts (Peak) | Added Filter |
|---|---|---|
| 0.5 mm. Al | 100 | 0.40 mm. Al |
| 1.0 mm. Al | 100 | 0.65 mm. Al |
| 1.5 mm. Al | 100 | 1.00 mm. Al |
| 2.0 mm. Al | 100 | 1.50 mm. Al |
| 2.5 mm. Al | 100 | 2.00 mm. Al |
| 3.0 mm. Al | 100 | 2.80 mm. Al |
| 4.0 mm. Al | 140 | 3.00 mm. Al |
| 0.5 mm. Cu | 145 | 0.25 mm. Cu |

## ISODOSE CURVES

The experimental data have been used to plot isodose curves for the following conditions.

| Field Diameter (cm.) | F.S.D. (cm.) | Half-Value Layer |
|---|---|---|
| 1, 1.5, 2, 3, 4, 5 | 15 | 0.5 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 15 | 1.0 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 15 | 1.5 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 15 | 2.0 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 15 | 2.5 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 15 | 3.0 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 21.5 | 4.0 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 21.5 | 0.5 mm. Cu |
| 1, 1.5, 2, 3, 4, 5 | 30 | 4.0 mm. Al |
| 1, 1.5, 2, 3, 4, 5 | 30 | 0.5 mm. Cu |
| 5, 10, 15, 20 | 30 | 0.5 mm. Al |
| 5, 10, 15, 20 | 30 | 1.0 mm. Al |
| 5, 10, 15, 20 | 30 | 1.5 mm. Al |
| 5, 10, 15, 20 | 30 | 2.0 mm. Al |
| 5, 10, 15, 20 | 30 | 2 5 mm. Al |
| 5, 10, 15, 20 | 30 | 3.0 mm. Al |

Two sources of radiation were used. One was a 100-kv self-rectified superficial therapy unit making use of a tube having a 2-mm. beryllium window. The other was a 250-kv self-rectified unit making use of a tube having a 4-mm. beryllium window.

In order to record the data for small fields, all the curves were drawn to 2× scale and then reduced photographically to a scale of 1. The results are shown in Figures 5 to 88.

## BACK-SCATTER DATA

No study of this kind is complete without back-scatter data for the conditions under consideration. Our back-scatter factor for the technics used are shown in Table I.

TABLE I: BACK-SCATTER FACTORS

| Half-Value Layer | Back-Scatter Factors | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Field Diameter (cm.) | | | | | | | | |
| | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 | 10.0 | 15.0 | 20.0 |
| 0.5 mm. Al | 1.03 | 1.05 | 1.06 | 1.08 | 1.09 | 1.11 | 1.14 | 1.15 | 1.16 |
| 1.0 mm. Al | 1.04 | 1.06 | 1.08 | 1.10 | 1.12 | 1.13 | 1.18 | 1.20 | 1.21 |
| 1.5 mm. Al | 1.04 | 1.06 | 1.08 | 1.12 | 1.14 | 1.15 | 1 21 | 1.24 | 1.25 |
| 2.0 mm. Al | 1.05 | 1.07 | 1.09 | 1.13 | 1.15 | 1.17 | 1.24 | 1.27 | 1.29 |
| 2.5 mm. Al | 1.05 | 1.08 | 1.10 | 1.14 | 1.16 | 1.18 | 1.26 | 1.29 | 1.32 |
| 3.0 mm. Al | 1.06 | 1.08 | 1.10 | 1.15 | 1.17 | 1.20 | 1.28 | 1.32 | 1.35 |
| 4.0 mm. Al | 1.05 | 1.07 | 1.09 | 1.14 | 1.17 | 1.20 | ... | ... | . |
| 0.5 mm. Cu | 1.05 | 1.07 | 1.10 | 1.14 | 1.18 | 1.21 | ... | ... | ... |

## CENTRAL-AXIS DEPTH DOSE

Although good central-axis depth dose information is available in even more complete form in the publications of other authors, it was thought worthwhile in the interest of completeness to include such tables in this paper. They are reproduced in Tables II to XVII.

## SUMMARY

Isodose curves with pertinent back-scatter and central axis depth doses for a wide range of technics used in superficial therapy have been presented. The experimental data are in good agreement with the recent work of other investigators.

Of especial interest is the reduced dose at the edge of these small fields, since this may have some significance in dose planning.

During the course of this study the authors have been interested in the influence of focal-spot size on the shape of the isodose curves for fields that approach the size of the focal spot. This effect will be studied, making use of a series of focal spots of different sizes. At the same time a study will be made of the interrelated effects of focal-spot and diaphragm position.

ACKNOWLEDGMENTS: The authors are indebted to Professor W. V. Mayneord and his associates who made available to them one of the Royal Cancer Hospital probes, to the many radiologists and physicists who have advised them, and to their secretary, Mrs. Velva D. Steenweg, who typed the records and the final manuscript.

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SUMARIO

**Curvas de Isodosis para la Terapéutica Superficial**

La introducción de pequeñas cámaras de yonización ha permitido trazar curvas de isodosis para los pequeños campos utilizados en la terapéutica superficial. Esto se ha hecho para valores de radiación de 0.5, 1, 2, 3, y 4 mm. de capa de hemirreducción de Al y 0.5 mm. de capa de hemirreducción de Cu. Uno de los problemas que se encuentran en dicha labor es el de la sombra lanzada por el mango de la cámara de yonización.

Descríbense los resultados de un estudio de dicho efecto y de las medidas tomadas para reducirlo.

DISCUSSION

**Wm. E. Costolow, M.D.** (Los Angeles, Calif.): I appreciate the honor of being invited to open the discussion of Dr. Trout's paper. His presentation represents a large amount of careful work, and his many charts and isodose curves will be of value to all of us using superficial x-ray therapy. It is seldom that one sees such a complete and painstaking compilation of any phase of radiology in a single presentation.

The work which has been carried on by Dr. Trout and his associates is an excellent confirmation of the situation as it was already understood. Therapists have realized that the dosages at the periphery of the field were less than those in the center of the field. This work removes low-voltage therapy from the region of conjecture to the area of definitiveness. The effectively flat response with voltage variation makes the instrument described a desirable piece of equipment.

On the basis of the isodose curves drawn by Dr. Trout, it appears doubtful that there will be any significant change in the method of treating skin cancer, but the treatment will be on a more scientific basis than in the past.

In the growth of skin epitheliomas—especially basal-cell epitheliomas—surgical excision has shown that often a few cells are scattered at the periphery of the estimated field of the lesion. In the past, even though the radiation dose has been less at the periphery of the field, it apparently has been sufficient to destroy isolated cells in these areas in most instances. Possibly the scattered cells at the periphery of the lesion require a lower cancerocidal dose than that needed in the center of the lesion. It has been established that treatment of superficial cancers by low voltage has been very satisfactory.

In a recent review of quite a large number of superficial cancers receiving low-voltage treatment, it was found that nearly all recurrences were outside the treated area. When there were recurrences in the irradiated area, they were present with equal frequency in the center and the periphery.

In examination of a superficial cancer there is no method of determining the extent of the lesion accurately. Guess and clinical experience are the only methods. It is most important, however, with low voltages to treat beyond the area of involvement and attempt to include a wide margin of healthy tissue. We believe that a large single-dose technic should be avoided and fractionation be carried out.

Dr. Trout's work will be of value to radiation therapists.

*For tables and isodose curves, see following pages.*

TABLE II: CENTER-LINE DEPTH DOSE, H.V.L. 0.5 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 97 | 95 | 94 | 93 | 92 | 90 |
| Back-Scatter Factor | 1.00 | 1.03 | 1.05 | 1.06 | 1.08 | 1.09 | 1.11 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 55 | 57 | 58 | 59 | 60 | 61 | 63 |
| 1.0 | 37 | 40 | 41 | 42 | 44 | 45 | 47 |
| 1.5 | 27 | 30 | 31 | 32 | 34 | 35 | 37 |
| 2.0 | 19 | 22 | 23 | 24 | 26 | 28 | 29 |
| 2.5 | 15 | 17 | 18 | 19 | 21 | 22 | 23 |
| 3.0 | 11 | 13 | 14 | 15 | 17 | 18 | 19 |
| 3.5 | 9 | 10 | 11 | 12 | 14 | 15 | 15 |
| 4.0 | .... | 8 | 9 | 10 | 11 | 12 | 13 |
| 4.5 | .... | .... | .... | 8 | 9 | 10 | 10 |
| 5.0 | .... | .... | .... | .... | .... | 8 | 9 |

TABLE III: CENTER-LINE DEPTH DOSE, H.V.L. 1.0 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 96 | 94 | 93 | 91 | 89 | 88 |
| Back-Scatter Factor | 1.00 | 1.04 | 1.06 | 1.08 | 1.10 | 1.12 | 1.13 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 66 | 67 | 68 | 69 | 69 | 70 | 71 |
| 1.0 | 46 | 49 | 50 | 52 | 53 | 54 | 56 |
| 1.5 | 34 | 37 | 39 | 41 | 42 | 43 | 45 |
| 2.0 | 25 | 29 | 30 | 32 | 34 | 35 | 36 |
| 2.5 | 20 | 23 | 24 | 26 | 27 | 28 | 30 |
| 3.0 | 15 | 18 | 19 | 20 | 22 | 23 | 25 |
| 3.5 | 12 | 14 | 16 | 17 | 18 | 19 | 20 |
| 4.0 | 10 | 12 | 13 | 13 | 15 | 16 | 17 |
| 4.5 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 5.0 | .... | .... | 8 | 9 | 10 | 11 | 12 |
| 5.5 | .... | .... | .... | .... | 8 | 9 | 10 |
| 6.0 | .... | .... | .... | .... | .... | .... | 9 |

TABLE IV: CENTER-LINE DEPTH DOSE, H.V.L. 1.5 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 96 | 94 | 93 | 89 | 88 | 87 |
| Back-Scatter Factor | 1.00 | 1.04 | 1.06 | 1.08 | 1.12 | 1.14 | 1.15 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 71 | 71 | 73 | 74 | 75 | 76 | 77 |
| 1.0 | 53 | 54 | 56 | 58 | 60 | 61 | 62 |
| 1.5 | 39 | 43 | 45 | 47 | 48 | 49 | 51 |
| 2.0 | 30 | 34 | 36 | 38 | 39 | 40 | 42 |
| 2.5 | 24 | 27 | 29 | 30 | 32 | 34 | 35 |
| 3.0 | 19 | 22 | 23 | 25 | 27 | 28 | 29 |
| 3.5 | 15 | 18 | 19 | 20 | 22 | 24 | 25 |
| 4.0 | 12 | 14 | 15 | 17 | 18 | 20 | 21 |
| 4.5 | 10 | 11 | 12 | 14 | 15 | 17 | 18 |
| 5.0 | 8 | 9 | 10 | 11 | 13 | 14 | 15 |
| 5.5 | .... | .... | 8 | 9 | 11 | 12 | 13 |
| 6.0 | .... | .... | .... | .... | 9 | 10 | 11 |
| 6.5 | .... | .... | .... | .... | .... | 9 | 9 |

TABLE V: CENTER-LINE DEPTH DOSE H.V.L. 2.0 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 94 | 92 | 88 | 87 | 85 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.07 | 1.09 | 1.13 | 1.15 | 1.17 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 74 | 75 | 77 | 78 | 80 | 81 | 82 |
| 1.0 | 56 | 58 | 61 | 63 | 65 | 66 | 67 |
| 1.5 | 43 | 47 | 49 | 52 | 53 | 55 | 56 |
| 2.0 | 34 | 38 | 40 | 42 | 44 | 45 | 47 |
| 2.5 | 27 | 30 | 33 | 35 | 37 | 38 | 40 |
| 3.0 | 22 | 25 | 27 | 28 | 30 | 32 | 34 |
| 3.5 | 17 | 20 | 22 | 23 | 25 | 27 | 29 |
| 4.0 | 14 | 17 | 18 | 19 | 21 | 23 | 24 |
| 4.5 | 11 | 13 | 15 | 16 | 18 | 19 | 21 |
| 5.0 | 9 | 11 | 12 | 13 | 15 | 17 | 18 |
| 5.5 | .... | 9 | 10 | 11 | 13 | 14 | 15 |
| 6.0 | .... | .... | 8 | 9 | 11 | 12 | 13 |
| 6.5 | .... | .... | .... | ... | 9 | 10 | 11 |
| 7.0 | .... | .... | .... | .... | .... | 9 | 10 |
| 7.5 | .... | .... | .... | .... | .... | .... | 9 |

TABLE VI: CENTER-LINE DEPTH DOSE, H.V.L. 2.5 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 93 | 91 | 88 | 86 | 85 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.08 | 1.10 | 1.14 | 1.16 | 1.18 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 76 | 77 | 79 | 80 | 82 | 83 | 84 |
| 1.0 | 59 | 61 | 64 | 66 | 68 | 69 | 71 |
| 1.5 | 47 | 50 | 52 | 54 | 57 | 58 | 60 |
| 2.0 | 37 | 41 | 43 | 45 | 48 | 49 | 51 |
| 2.5 | 30 | 33 | 35 | 37 | 40 | 42 | 43 |
| 3.0 | 24 | 27 | 29 | 31 | 34 | 35 | 37 |
| 3.5 | 19 | 22 | 24 | 26 | 29 | 30 | 31 |
| 4.0 | 16 | 18 | 20 | 22 | 24 | 26 | 27 |
| 4.5 | 13 | 15 | 16 | 18 | 20 | 22 | 23 |
| 5.0 | 10 | 13 | 14 | 15 | 17 | 19 | 20 |
| 5.5 | 8 | 10 | 11 | 13 | 14 | 16 | 17 |
| 6.0 | .... | 9 | 9 | 11 | 12 | 14 | 15 |
| 6.5 | .... | .... | .... | 9 | 10 | 12 | 13 |
| 7.0 | .... | .... | .... | .... | 9 | 10 | 11 |
| 7.5 | .... | .... | .... | .... | .... | 9 | 10 |
| 8.0 | .... | .... | .... | .... | .... | .... | 8 |

TABLE VII: CENTER-LINE DEPTH DOSE, H.V.L. 3.0 MM. AL, 15 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 94 | 93 | 91 | 87 | 85 | 83 |
| Back-Scatter Factor | 1.00 | 1.06 | 1.08 | 1.10 | 1.15 | 1.17 | 1.20 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 78 | 80 | 81 | 82 | 84 | 86 | 88 |
| 1.0 | 62 | 64 | 66 | 68 | 70 | 71 | 73 |
| 1.5 | 50 | 52 | 54 | 57 | 59 | 61 | 62 |
| 2.0 | 40 | 43 | 45 | 47 | 50 | 52 | 53 |
| 2.5 | 32 | 35 | 38 | 40 | 42 | 45 | 46 |
| 3.0 | 26 | 30 | 31 | 34 | 36 | 39 | 40 |
| 3.5 | 21 | 25 | 26 | 28 | 31 | 33 | 35 |
| 4.0 | 18 | 21 | 22 | 24 | 26 | 28 | 30 |
| 4.5 | 15 | 17 | 18 | 20 | 22 | 24 | 26 |
| 5.0 | 12 | 14 | 15 | 17 | 19 | 21 | 22 |
| 5.5 | 10 | 12 | 13 | 14 | 16 | 18 | 19 |
| 6.0 | 8 | 10 | 11 | 12 | 14 | 15 | 17 |
| 6.5 | .... | 8 | 9 | 10 | 12 | 13 | 15 |
| 7.0 | .... | .... | .... | 9 | 10 | 12 | 13 |
| 7.5 | .... | .... | .... | .... | 8 | 10 | 11 |
| 8.0 | .... | .... | .... | .... | .... | 8 | 9 |

TABLE VIII: CENTER-LINE DEPTH DOSE, H.V.L. 4.0 MM. AL, 21.5 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 93 | 92 | 88 | 85 | 83 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.07 | 1.09 | 1.14 | 1.17 | 1.20 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 82 | 83 | 84 | 86 | 88 | 89 | 90 |
| 1.0 | 68 | 69 | 71 | 74 | 77 | 79 | 80 |
| 1.5 | 57 | 58 | 60 | 63 | 67 | 69 | 71 |
| 2.0 | 48 | 49 | 51 | 54 | 58 | 61 | 62 |
| 2.5 | 40 | 41 | 44 | 46 | 50 | 53 | 55 |
| 3.0 | 34 | 35 | 37 | 40 | 43 | 46 | 48 |
| 3.5 | 29 | 30 | 32 | 34 | 37 | 40 | 43 |
| 4.0 | 25 | 26 | 27 | 29 | 32 | 35 | 38 |
| 4.5 | 21 | 22 | 24 | 25 | 28 | 31 | 33 |
| 5.0 | 19 | 19 | 20 | 22 | 25 | 27 | 29 |
| 5.5 | 15 | 16 | 18 | 19 | 21 | 24 | 26 |
| 6.0 | 13 | 14 | 15 | 17 | 19 | 21 | 23 |
| 6.5 | 11 | 12 | 13 | 14 | 16 | 18 | 20 |
| 7.0 | 9 | 10 | 11 | 13 | 14 | 16 | 17 |
| 7.5 | .... | 9 | 10 | 11 | 13 | 14 | 16 |
| 8.0 | .... | .... | 9 | 9 | 11 | 12 | 14 |
| 8.5 | .... | .... | .... | .... | 10 | 11 | 12 |
| 9.0 | .... | .... | .... | .... | 8 | 10 | 11 |
| 9.5 | .... | .... | .... | .... | .... | 9 | 9 |
| 10.0 | .... | .... | .... | .... | .... | .... | .... |

TABLE IX: CENTER-LINE DEPTH DOSE, H.V.L. 0.5 MM. CU, 21.5 CM. F.S.D.

| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 93 | 91 | 88 | 85 | 82 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.07 | 1.10 | 1.14 | 1.18 | 1.21 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 83 | 85 | 86 | 87 | 89 | 91 | 93 |
| 1.0 | 72 | 73 | 74 | 76 | 79 | 82 | 86 |
| 1.5 | 62 | 63 | 64 | 66 | 70 | 74 | 79 |
| 2.0 | 53 | 54 | 56 | 58 | 62 | 66 | 71 |
| 2.5 | 47 | 48 | 50 | 52 | 55 | 59 | 64 |
| 3.0 | 41 | 42 | 44 | 46 | 49 | 53 | 57 |
| 3.5 | 35 | 37 | 38 | 41 | 44 | 48 | 51 |
| 4.0 | 30 | 32 | 34 | 36 | 39 | 43 | 46 |
| 4.5 | 27 | 28 | 30 | 32 | 35 | 38 | 41 |
| 5.0 | 23 | 25 | 26 | 28 | 31 | 34 | 37 |
| 5.5 | 20 | 21 | 23 | 25 | 27 | 30 | 33 |
| 6.0 | 17 | 19 | 20 | 22 | 24 | 27 | 29 |
| 6.5 | 15 | 16 | 18 | 20 | 22 | 24 | 26 |
| 7.0 | 13 | 14 | 16 | 17 | 19 | 21 | 23 |
| 7.5 | 11 | 12 | 14 | 15 | 17 | 19 | 21 |
| 8.0 | 10 | 11 | 12 | 14 | 15 | 17 | 19 |
| 8.5 | 8 | 9 | 11 | 12 | 14 | 15 | 17 |
| 9.0 | .... | .... | 9 | 11 | 12 | 14 | 15 |
| 9.5 | .... | .... | .... | 10 | 11 | 12 | 13 |
| 10.0 | .... | .... | .... | 8 | 10 | 11 | 12 |
| 10.5 | .... | .... | .... | .... | 9 | 10 | 11 |
| 11.0 | .... | .... | .... | .... | .... | 9 | 9 |

TABLE X: CENTER-LINE DEPTH DOSE, H.V.L. 0.5 MM. AL, 30 CM. F.S.D.

| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5.0 | 10.0 | 15.0 | 20.0 |
| Air Dose | 100 | 90 | 88 | 87 | 86 |
| Back-Scatter Factor | 1.00 | 1.11 | 1.14 | 1.15 | 1.16 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 57 | 67 | 68 | 69 | 69 |
| 1.0 | 39 | 51 | 54 | 55 | 55 |
| 1.5 | 29 | 40 | 43 | 44 | 45 |
| 2.0 | 22 | 32 | 35 | 37 | 37 |
| 2.5 | 17 | 27 | 30 | 31 | 32 |
| 3.0 | 14 | 22 | 25 | 27 | 27 |
| 3.5 | 11 | 18 | 21 | 23 | 23 |
| 4.0 | 9 | 15 | 18 | 20 | 20 |
| 4.5 | .... | 13 | 16 | 17 | 18 |
| 5.0 | .... | 11 | 14 | 15 | 16 |
| 5.5 | .... | 9 | 12 | 13 | 14 |
| 6.0 | .... | .... | 10 | 11 | 12 |
| 6.5 | .... | .... | .... | 10 | 11 |
| 7.0 | .... | .... | .... | .... | 10 |

TABLE XI: CENTER-LINE DEPTH DOSE, H.V.L. 1.0 MM. AL, 30 CM. F.S.D.

| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5 | 10 | 15 | 20 |
| Air Dose | 100 | 89 | 85 | 83 | 82 |
| Back-Scatter Factor | 1.00 | 1.13 | 1.18 | 1.20 | 1.21 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 68 | 77 | 78 | 79 | 80 |
| 1.0 | 50 | 61 | 64 | 65 | 66 |
| 1.5 | 38 | 49 | 53 | 54 | 55 |
| 2.0 | 29 | 41 | 44 | 46 | 47 |
| 2.5 | 23 | 34 | 38 | 40 | 41 |
| 3.0 | 18 | 28 | 32 | 35 | 36 |
| 3.5 | 15 | 24 | 28 | 30 | 31 |
| 4.0 | 12 | 20 | 24 | 26 | 27 |
| 4.5 | 10 | 17 | 21 | 23 | 24 |
| 5.0 | 8 | 14 | 18 | 20 | 21 |
| 5.5 | .... | 12 | 16 | 18 | 19 |
| 6.0 | .... | 10 | 14 | 16 | 17 |
| 6.5 | .... | .... | 12 | 14 | 15 |
| 7.0 | .... | .... | 10 | 12 | 13 |
| 7.5 | .... | .... | .... | 11 | 12 |
| 8.0 | .... | .... | .... | 10 | 10 |
| 8.5 | .... | .... | .... | .... | .... |

TABLE XII: CENTER-LINE DEPTH DOSE, H.V.L. 1.5 MM. AL, 30 CM. F.S.D.

| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5 | 10 | 15 | 20 |
| Air Dose | 100 | 87 | 83 | 81 | 80 |
| Back-Scatter Factor | 1.00 | 1.15 | 1.21 | 1.24 | 1.25 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 75 | 82 | 83 | 84 | 84 |
| 1.0 | 57 | 68 | 70 | 71 | 72 |
| 1.5 | 44 | 57 | 60 | 62 | 63 |
| 2.0 | 34 | 48 | 51 | 54 | 55 |
| 2.5 | 28 | 40 | 44 | 47 | 48 |
| 3.0 | 22 | 34 | 39 | 41 | 42 |
| 3.5 | 18 | 29 | 34 | 36 | 37 |
| 4.0 | 15 | 25 | 29 | 32 | 33 |
| 4.5 | 13 | 21 | 26 | 28 | 29 |
| 5.0 | 10 | 18 | 22 | 25 | 26 |
| 5.5 | 9 | 15 | 20 | 22 | 23 |
| 6.0 | .... | 13 | 17 | 19 | 20 |
| 6.5 | .... | 12 | 15 | 17 | 18 |
| 7.0 | .... | 10 | 13 | 15 | 16 |
| 7.5 | .... | .... | 12 | 13 | 15 |
| 8.0 | .... | .... | 10 | 12 | 13 |
| 8.5 | .... | .... | .... | 11 | 12 |
| 9.0 | .... | .... | .... | 10 | 11 |
| 9.5 | .... | .... | .... | .... | 10 |

TABLE XIII: CENTER-LINE DEPTH DOSE, H.V.L. 2.0 MM. AL, 30 CM. F.S.D.

| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5 | 10 | 15 | 20 |
| Air Dose | 100 | 86 | 81 | 79 | 77 |
| Back-Scatter Factor | 1.00 | 1.17 | 1.24 | 1.27 | 1.29 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 77 | 86 | 87 | 88 | 88 |
| 1.0 | 60 | 73 | 76 | 77 | 78 |
| 1.5 | 47 | 63 | 66 | 67 | 69 |
| 2.0 | 38 | 54 | 58 | 59 | 61 |
| 2.5 | 31 | 46 | 51 | 53 | 54 |
| 3.0 | 26 | 39 | 45 | 47 | 48 |
| 3.5 | 21 | 34 | 39 | 42 | 43 |
| 4.0 | 18 | 29 | 35 | 37 | 38 |
| 4.5 | 15 | 25 | 30 | 33 | 34 |
| 5.0 | 12 | 21 | 27 | 29 | 31 |
| 5.5 | 10 | 19 | 24 | 26 | 27 |
| 6.0 | 8 | 16 | 21 | 23 | 25 |
| 6.5 | .... | 14 | 18 | 21 | 22 |
| 7.0 | .... | 12 | 16 | 19 | 20 |
| 7.5 | .... | 10 | 15 | 17 | 18 |
| 8.0 | .... | .... | 13 | 15 | 16 |
| 8.5 | .... | .... | 11 | 13 | 14 |
| 9.0 | .... | .... | 10 | 12 | 13 |
| 9.5 | .... | .... | .... | 11 | 12 |
| 10.0 | .... | .... | .... | 10 | 11 |
| 10.5 | .... | .... | .... | .... | 10 |

TABLE XIV: CENTER-LINE DEPTH DOSE, H.V.L. 2 5 MM. AL, 30 CM. F.S.D.

| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5 | 10 | 15 | 20 |
| Air Dose | 100 | 85 | 79 | 77 | 76 |
| Back-Scatter Factor | 1.00 | 1.18 | 1.26 | 1.29 | 1.32 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 79 | 88 | 89 | 90 | 91 |
| 1.0 | 62 | 77 | 80 | 81 | 82 |
| 1.5 | 51 | 67 | 71 | 72 | 74 |
| 2.0 | 42 | 58 | 63 | 65 | 67 |
| 2.5 | 34 | 50 | 56 | 58 | 60 |
| 3.0 | 28 | 43 | 50 | 52 | 54 |
| 3.5 | 24 | 38 | 44 | 47 | 48 |
| 4.0 | 20 | 32 | 39 | 42 | 43 |
| 4.5 | 16 | 28 | 34 | 37 | 39 |
| 5.0 | 14 | 23 | 30 | 33 | 35 |
| 5.5 | 11 | 21 | 27 | 30 | 31 |
| 6.0 | 10 | 19 | 24 | 26 | 28 |
| 6.5 | 8 | 16 | 21 | 24 | 25 |
| 7.0 | .... | 14 | 19 | 21 | 23 |
| 7.5 | .... | 12 | 17 | 19 | 20 |
| 8.0 | .... | 11 | 15 | 17 | 18 |
| 8.5 | .... | 10 | 13 | 15 | 17 |
| 9.0 | .... | .... | 12 | 14 | 15 |
| 9.5 | .... | .... | 10 | 12 | 14 |
| 10.0 | .... | .... | .... | 11 | 12 |
| 10.5 | .... | .... | .... | 10 | 11 |
| 11.0 | .... | .... | .... | .... | 10 |

TABLE XV: CENTER-LINE DEPTH DOSE, H.V.L. 3.0 MM. AL, 30 CM. F.S.D.

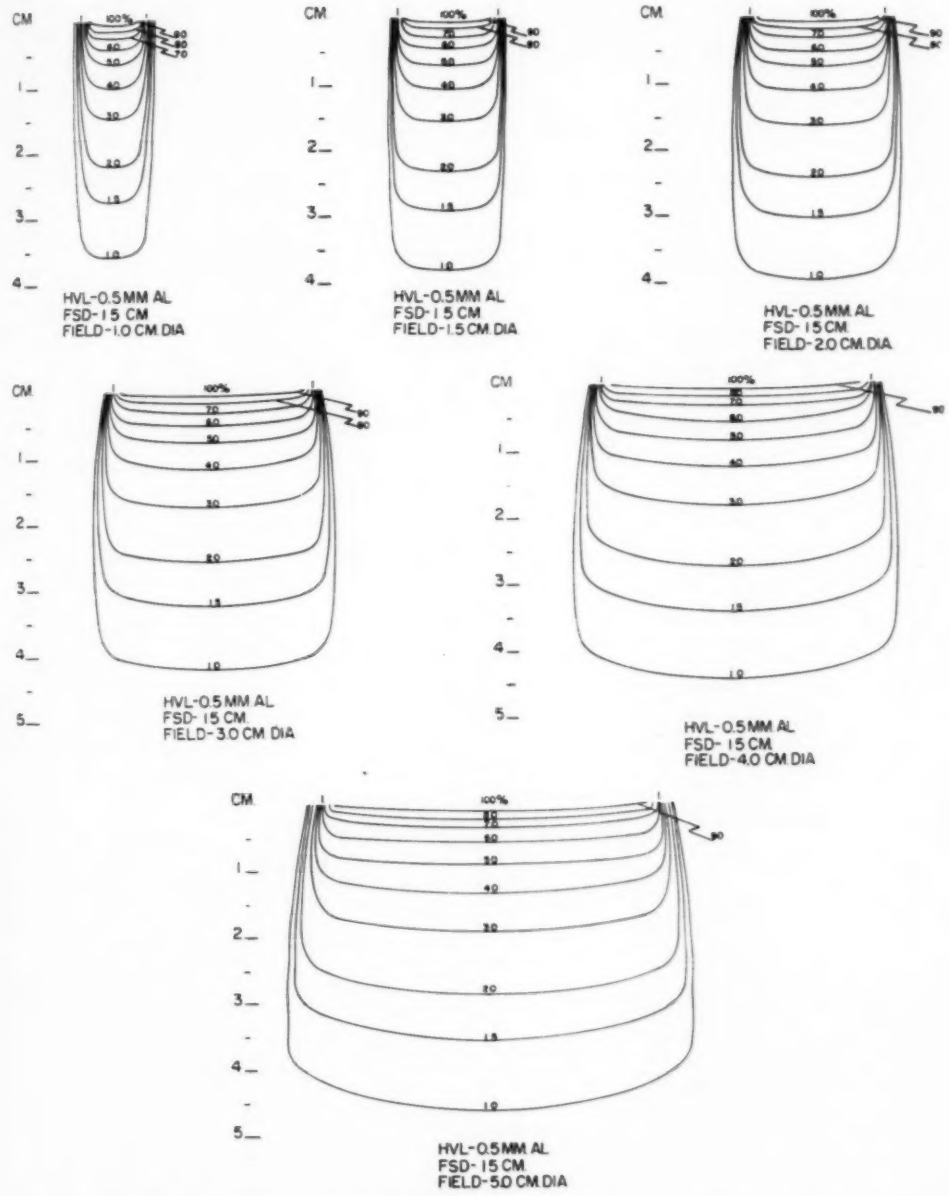
| Area of Field (cm.²) | 0 | 20 | 79 | 177 | 314 |
|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 5 | 10 | 15 | 20 |
| Air Dose | 100 | 83 | 78 | 76 | 74 |
| Back-Scatter Factor | 1.0 | 1.20 | 1.28 | 1.32 | 1.35 |
| Depth (cm.) | Per Cent Depth Dose | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 81 | 89 | 91 | 92 | 93 |
| 1.0 | 65 | 79 | 83 | 84 | 86 |
| 1.5 | 54 | 70 | 75 | 77 | 78 |
| 2.0 | 45 | 62 | 67 | 69 | 71 |
| 2.5 | 37 | 54 | 60 | 63 | 65 |
| 3.0 | 31 | 47 | 54 | 56 | 59 |
| 3.5 | 26 | 41 | 48 | 51 | 53 |
| 4.0 | 22 | 36 | 43 | 46 | 48 |
| 4.5 | 19 | 31 | 38 | 41 | 43 |
| 5.0 | 16 | 27 | 34 | 37 | 39 |
| 5.5 | 13 | 24 | 30 | 33 | 35 |
| 6.0 | 11 | 21 | 27 | 30 | 32 |
| 6.5 | 9 | 18 | 24 | 27 | 29 |
| 7.0 | .... | 16 | 21 | 24 | 26 |
| 7.5 | .... | 14 | 19 | 22 | 23 |
| 8.0 | .... | 13 | 17 | 20 | 21 |
| 8.5 | .... | 11 | 15 | 18 | 19 |
| 9.0 | .... | 10 | 14 | 16 | 17 |
| 9.5 | .... | .... | 12 | 14 | 16 |
| 10.0 | .... | .... | 11 | 13 | 14 |
| 10.5 | .... | .... | 10 | 12 | 13 |
| 11.0 | .... | .... | .... | 11 | 12 |
| 11.5 | .... | .... | .... | 10 | 11 |
| 12.0 | .... | .... | .... | .... | 10 |

TABLE XVI: CENTER-LINE DEPTH DOSE, H.V.L. 4.0 MM. AL, 30 CM. F.S.D.

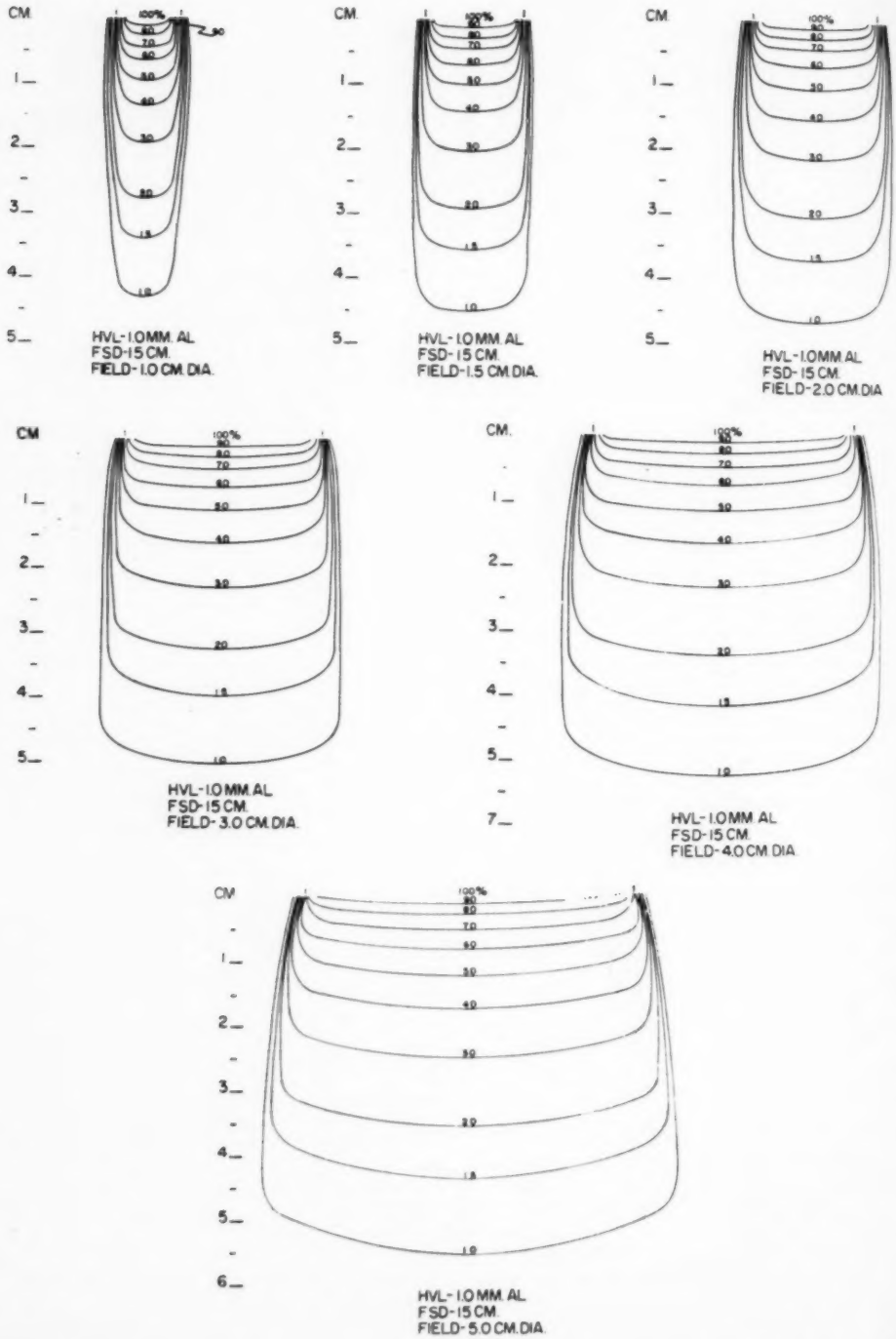
| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 93 | 92 | 88 | 85 | 83 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.07 | 1.09 | 1.14 | 1.17 | 1.20 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 82 | 83 | 85 | 86 | 88 | 89 | 91 |
| 1.0 | 68 | 70 | 73 | 75 | 78 | 80 | 82 |
| 1.5 | 57 | 60 | 63 | 65 | 68 | 70 | 73 |
| 2.0 | 50 | 51 | 54 | 56 | 59 | 62 | 65 |
| 2.5 | 42 | 44 | 47 | 49 | 52 | 55 | 58 |
| 3.0 | 36 | 38 | 40 | 43 | 46 | 49 | 51 |
| 3.5 | 31 | 32 | 35 | 37 | 40 | 43 | 45 |
| 4.0 | 26 | 28 | 30 | 32 | 36 | 38 | 40 |
| 4.5 | 22 | 24 | 26 | 28 | 31 | 34 | 36 |
| 5.0 | 20 | 21 | 23 | 25 | 27 | 30 | 32 |
| 5.5 | 17 | 18 | 20 | 22 | 24 | 26 | 28 |
| 6.0 | 15 | 16 | 18 | 19 | 21 | 23 | 25 |
| 6.5 | 13 | 14 | 15 | 17 | 19 | 21 | 22 |
| 7.0 | 11 | 12 | 13 | 15 | 17 | 18 | 20 |
| 7.5 | 10 | 10 | 12 | 13 | 14 | 16 | 18 |
| 8.0 | 9 | 9 | 10 | 11 | 13 | 14 | 16 |
| 8.5 | .... | .... | 9 | 10 | 11 | 13 | 14 |
| 9.0 | .... | .... | .... | 9 | 10 | 11 | 13 |
| 9.5 | .... | .... | .... | .... | 9 | 10 | 11 |
| 10.0 | .... | .... | .... | .... | .... | 9 | 10 |
| 10.5 | .... | .... | .... | .... | .... | .... | 9 |

TABLE XVII: CENTER-LINE DEPTH DOSE, H.V.L. 0.5 MM. CU, 30 CM. F.S.D.

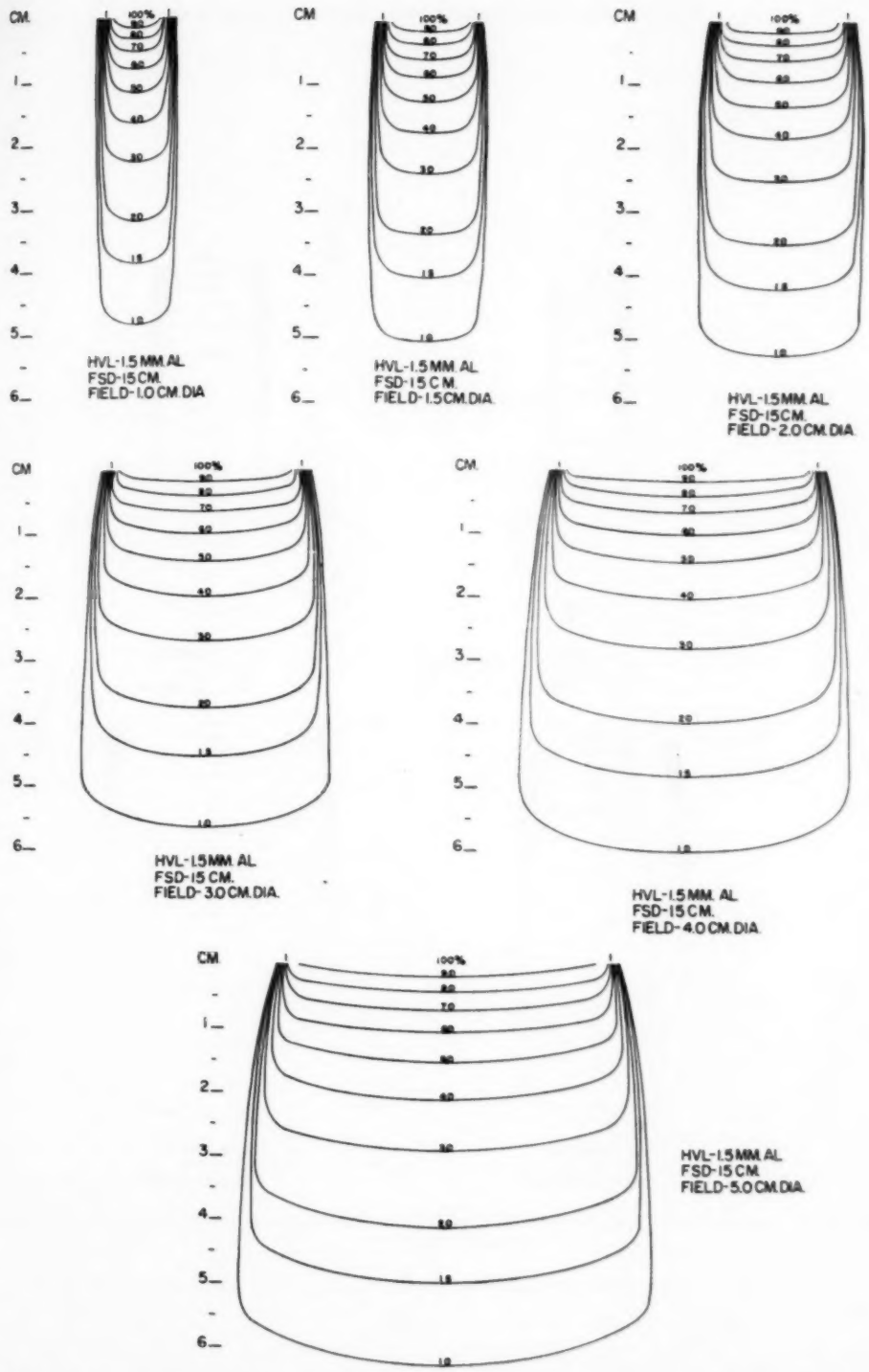
| Area of Field (cm.²) | 0 | 0.8 | 1.8 | 3.1 | 7.1 | 12.5 | 19.6 |
|---|---|---|---|---|---|---|---|
| Diameter (cm.) | 0 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| Air Dose | 100 | 95 | 93 | 91 | 88 | 85 | 82 |
| Back-Scatter Factor | 1.00 | 1.05 | 1.07 | 1.10 | 1.14 | 1.18 | 1.21 |
| Depth (cm.) | Per Cent Depth Dose | | | | | | |
| 0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 0.5 | 84 | 86 | 87 | 88 | 91 | 92 | 94 |
| 1.0 | 74 | 74 | 77 | 79 | 82 | 84 | 88 |
| 1.5 | 64 | 65 | 68 | 70 | 74 | 77 | 81 |
| 2.0 | 56 | 57 | 60 | 62 | 67 | 70 | 74 |
| 2.5 | 49 | 50 | 53 | 55 | 60 | 63 | 67 |
| 3.0 | 43 | 44 | 47 | 49 | 53 | 57 | 61 |
| 3.5 | 38 | 39 | 42 | 44 | 48 | 51 | 55 |
| 4.0 | 32 | 34 | 37 | 39 | 43 | 46 | 50 |
| 4.5 | 29 | 30 | 33 | 35 | 38 | 42 | 45 |
| 5.0 | 25 | 27 | 29 | 31 | 34 | 37 | 40 |
| 5.5 | 20 | 23 | 26 | 27 | 31 | 33 | 36 |
| 6.0 | 18 | 21 | 23 | 24 | 27 | 30 | 33 |
| 6.5 | 16 | 18 | 20 | 22 | 24 | 27 | 29 |
| 7.0 | 14 | 16 | 18 | 19 | 22 | 24 | 26 |
| 7.5 | 12 | 14 | 16 | 17 | 19 | 22 | 24 |
| 8.0 | 11 | 12 | 14 | 15 | 17 | 19 | 21 |
| 8.5 | 10 | 11 | 12 | 14 | 16 | 17 | 19 |
| 9.0 | 9 | 10 | 11 | 12 | 14 | 16 | 17 |
| 9.5 | .... | 8 | 10 | 11 | 12 | 14 | 16 |
| 10.0 | .... | .... | 8 | 10 | 11 | 13 | 14 |
| 10.5 | .... | .... | .... | 9 | 10 | 11 | 12 |
| 11.0 | .... | .... | .... | .... | 9 | 10 | 11 |
| 11.5 | .... | .... | .... | .... | .... | 9 | 10 |
| 12.0 | .... | .... | .... | .... | .... | .... | 9 |



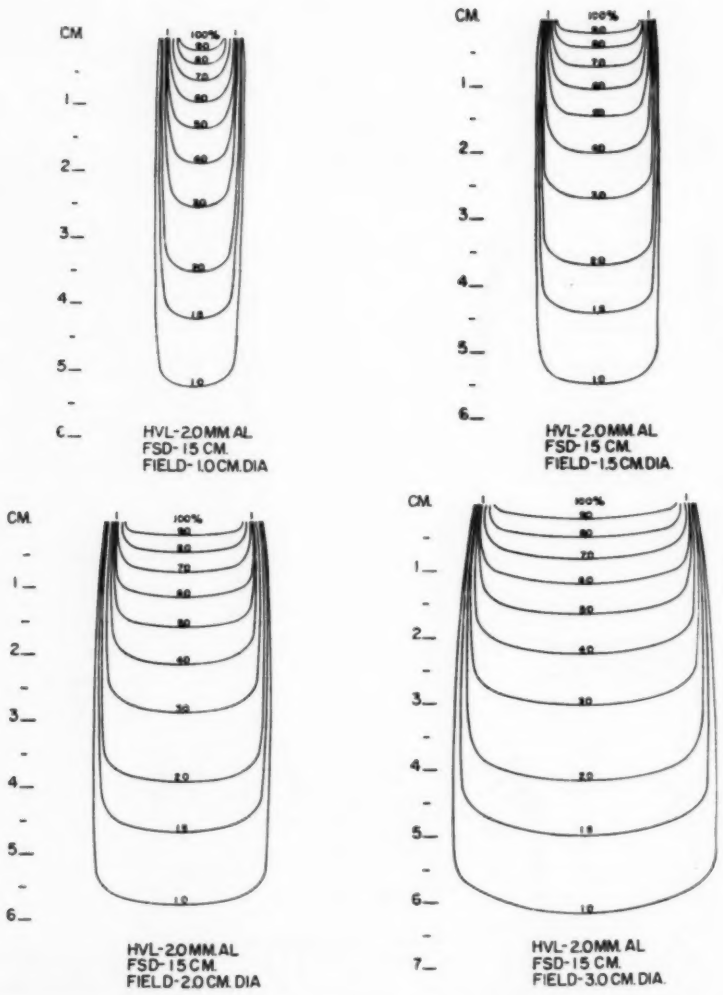

Figs. 5–10. Isodose curves, h.v.l. 0.5 mm. Al, 15 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm. 3.0 cm., 4.0 cm., 5.0 cm.



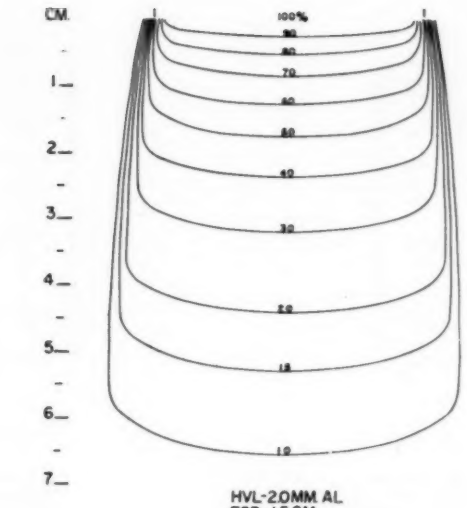

**Figs. 11–16.** Isodose curves, h.v.l. 1.0 mm. Al, 15 cm. F.D.S., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm., 4.0 cm., 5.0 cm.

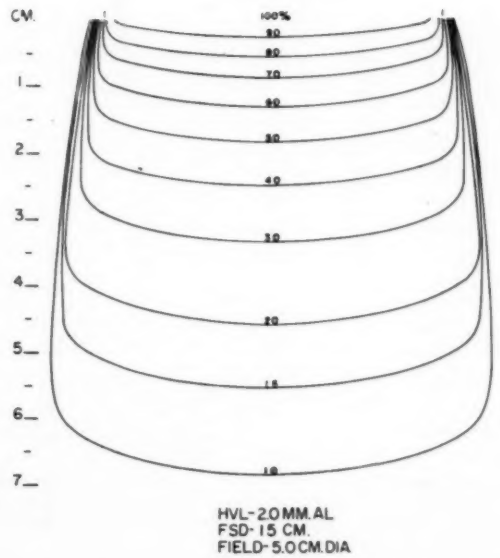



Figs. 17–22. Isodose curves, h.v.l. 1.5 mm. Al, 15 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm., 4.0 cm., 5.0 cm.

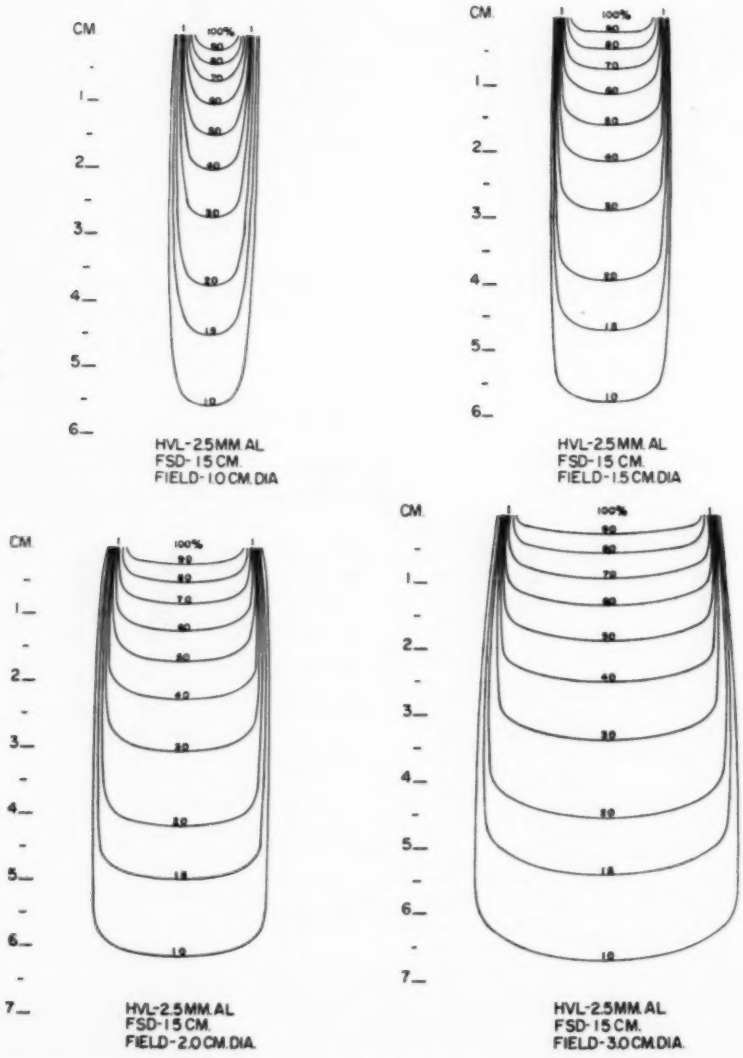



Figs. 23–26. Isodose curves, h.v.l. 2.0 mm. Al, 15 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.

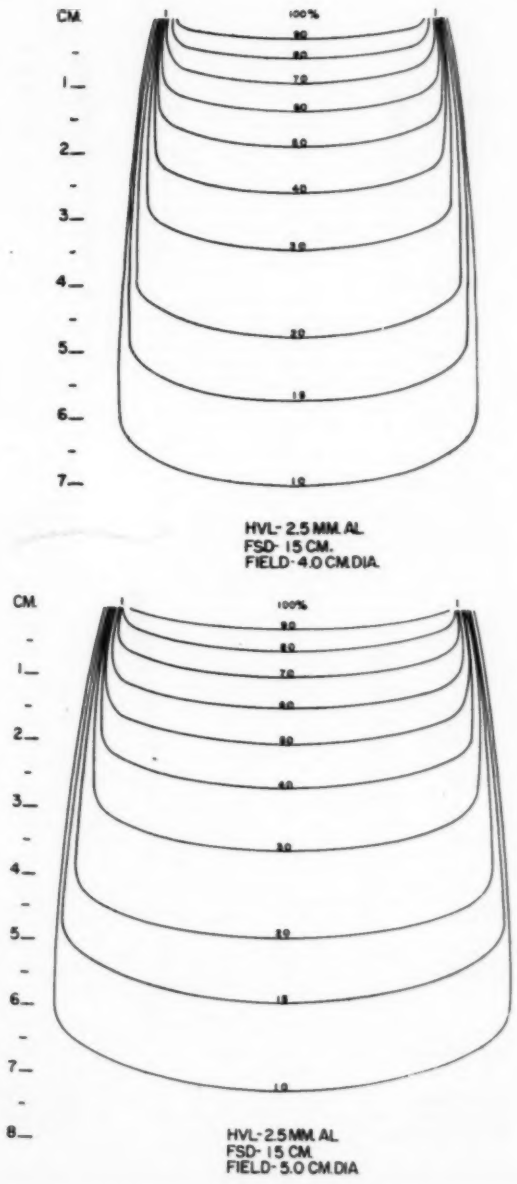


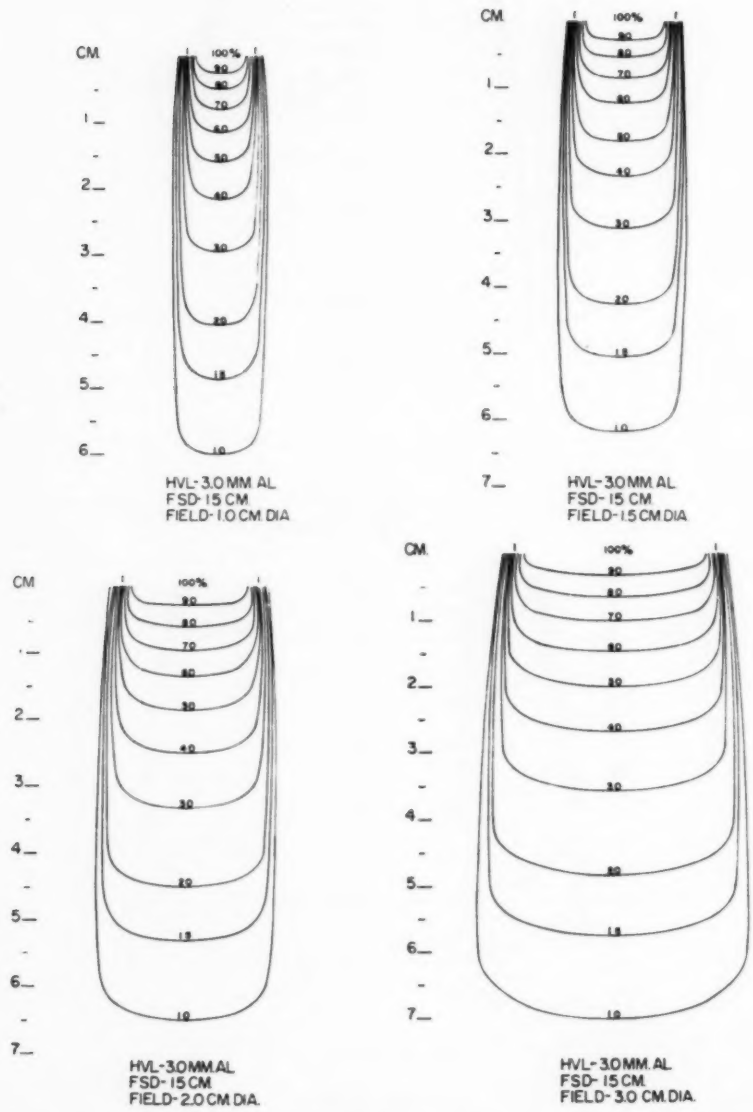

Figs. 27–28. Isodose curves, h.v.l. 2.0 mm. Al, 15 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.



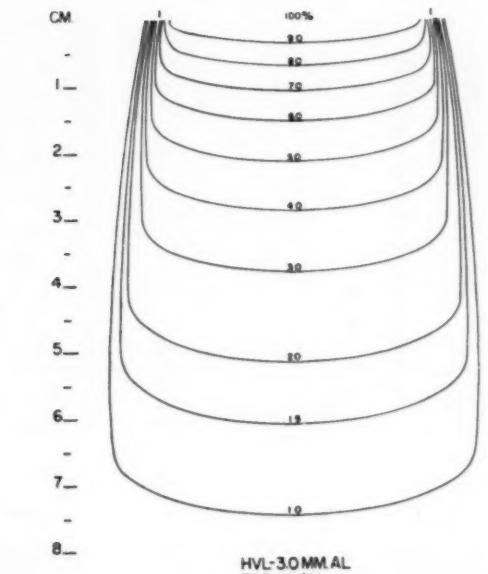

Figs. 29–32. Isodose curves, h.v.l. 2.5 mm. Al, 15 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.

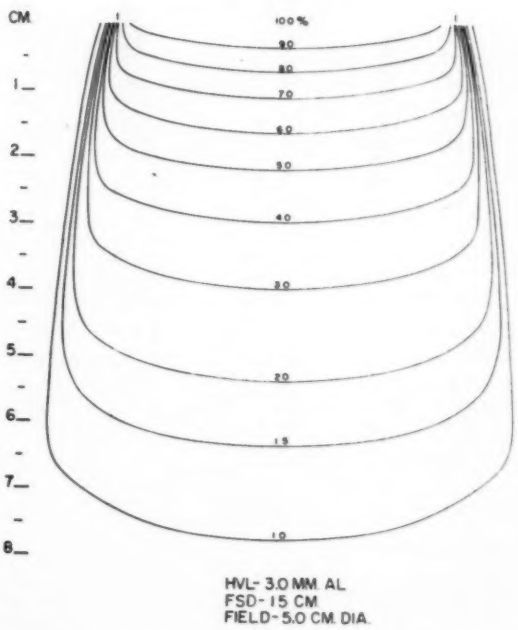



Figs. 33–34. Isodose curves, h.v.l. 2.5 mm. Al, 15 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.

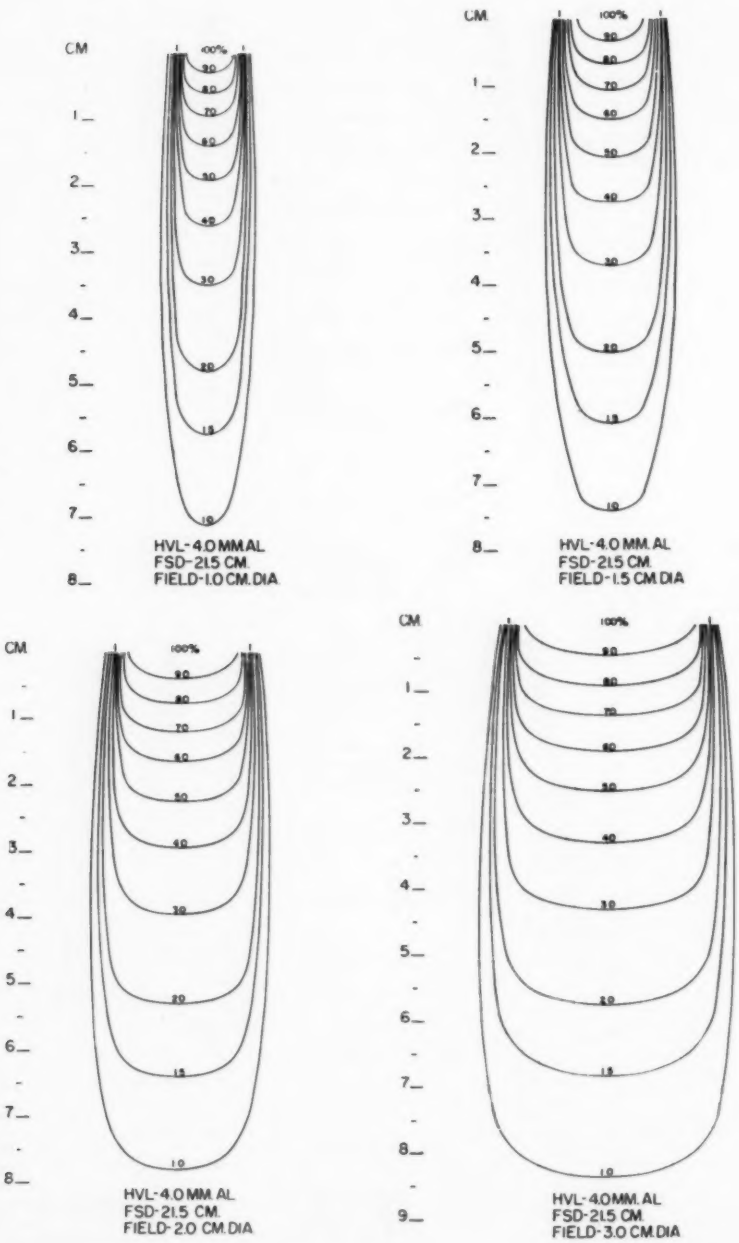



Figs. 35–38. Isodose curves, h.v.l. 3.0 mm. Al, 15 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.

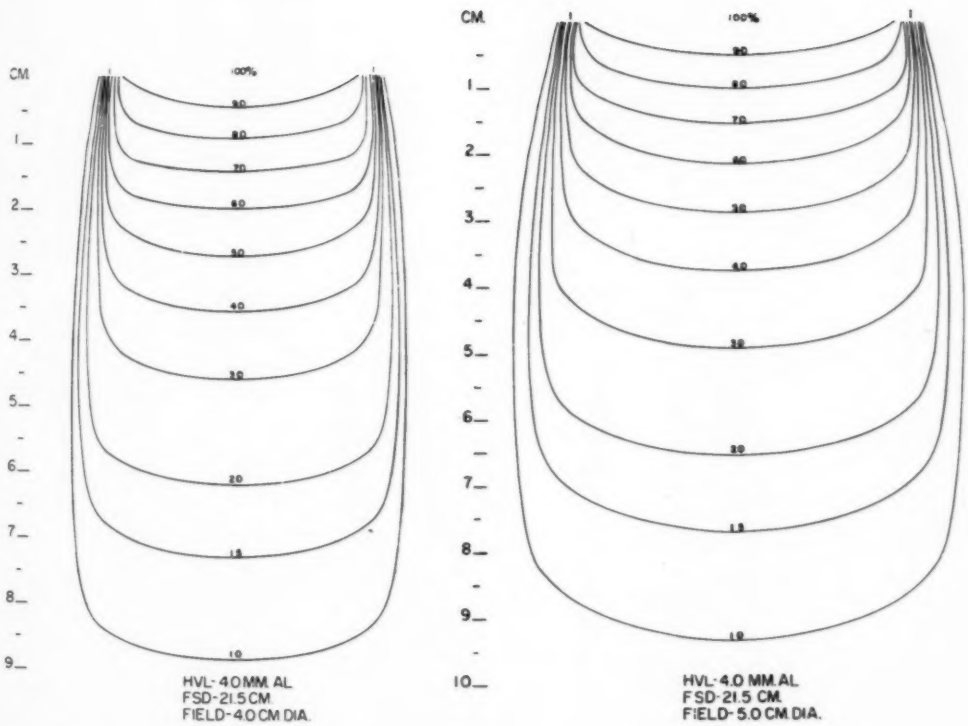


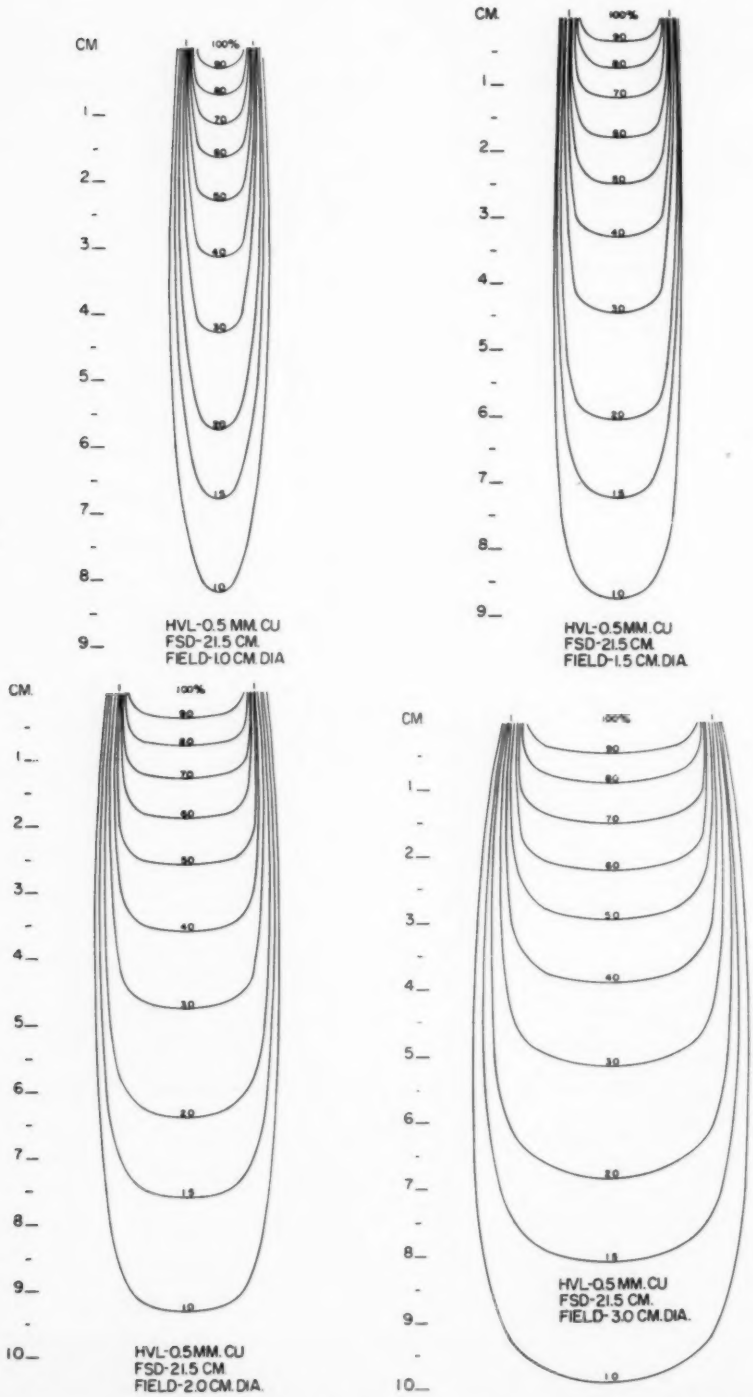

Figs. 39–40. Isodose curves, h.v.l. 3.0 mm. Al, 15 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.



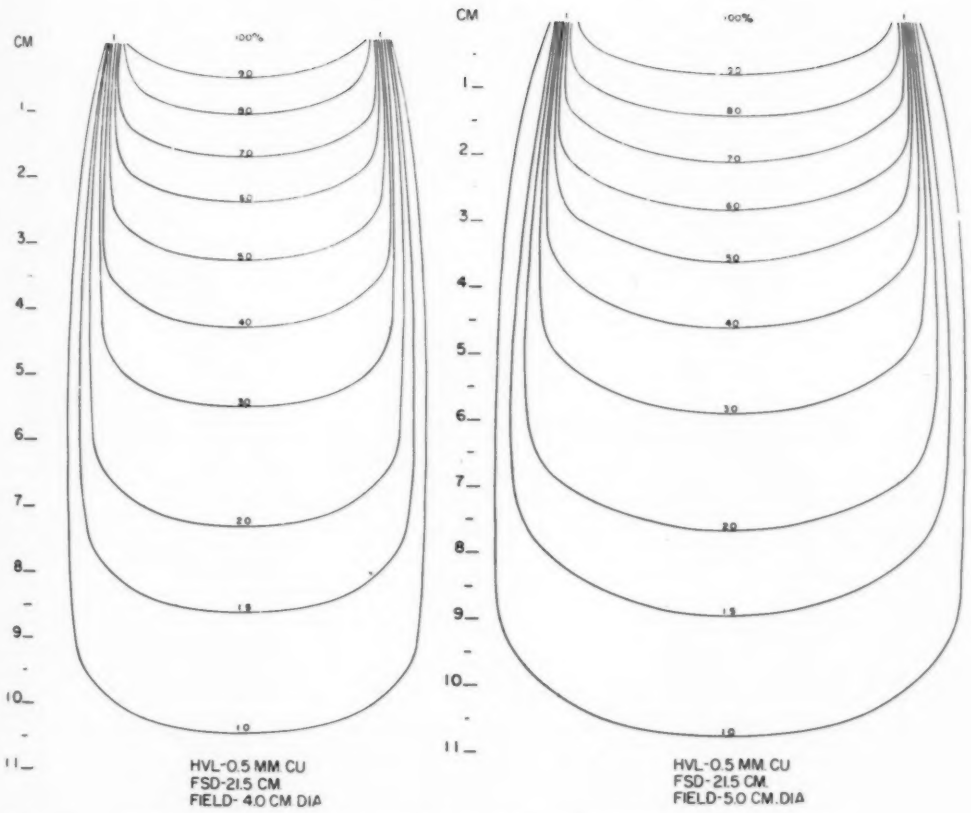

Figs. 41–44. Isodose curves, h.v.l. 4.0 mm. Al, 21.5 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.



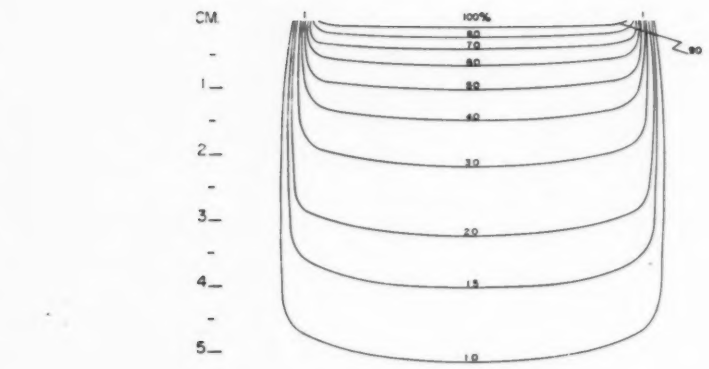

Figs. 45–46. Isodose curves, h.v.l. 4.0 mm. Al, 21.5 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.

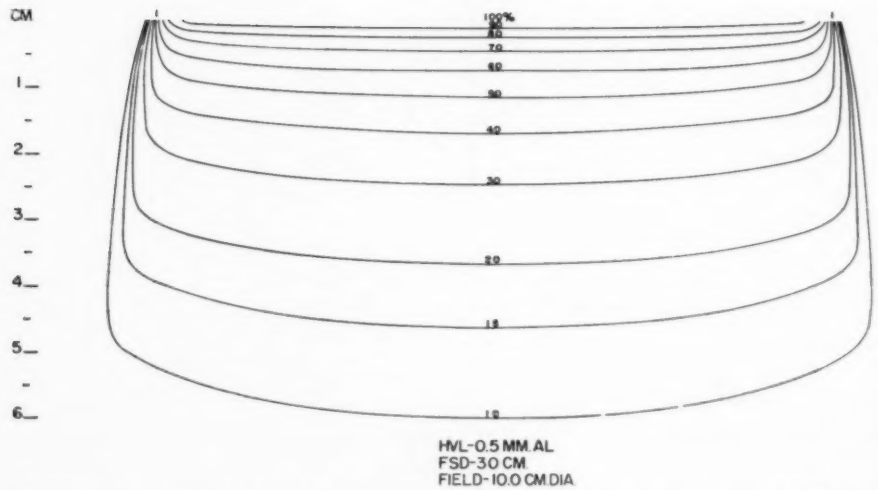



Figs. 47–50. Isodose curves, h.v.l. 0.5 mm. Cu, 21.5 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.

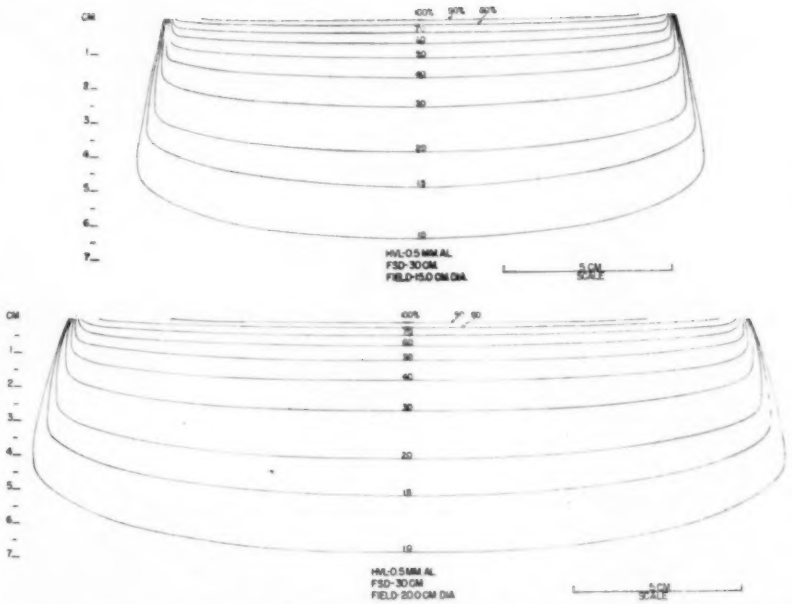



Figs. 51–52. Isodose curves, h.v.l. 0.5 mm. Cu, 21.5 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.

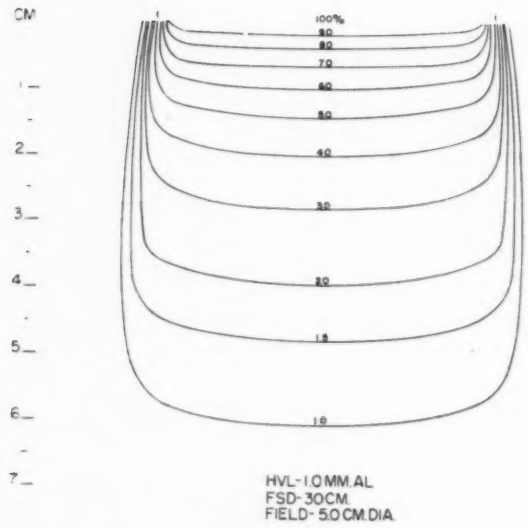


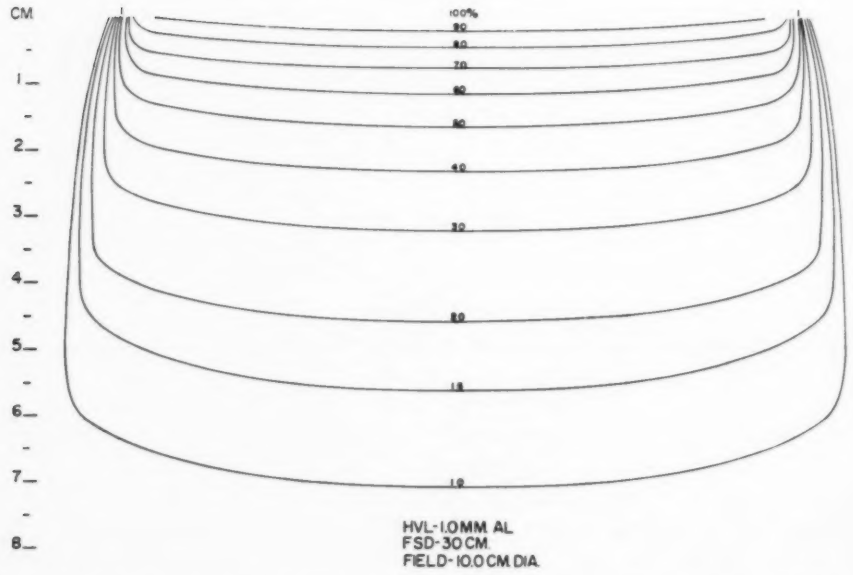




Figs. 53–54. Isodose curves, h.v.l. 0.5 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.

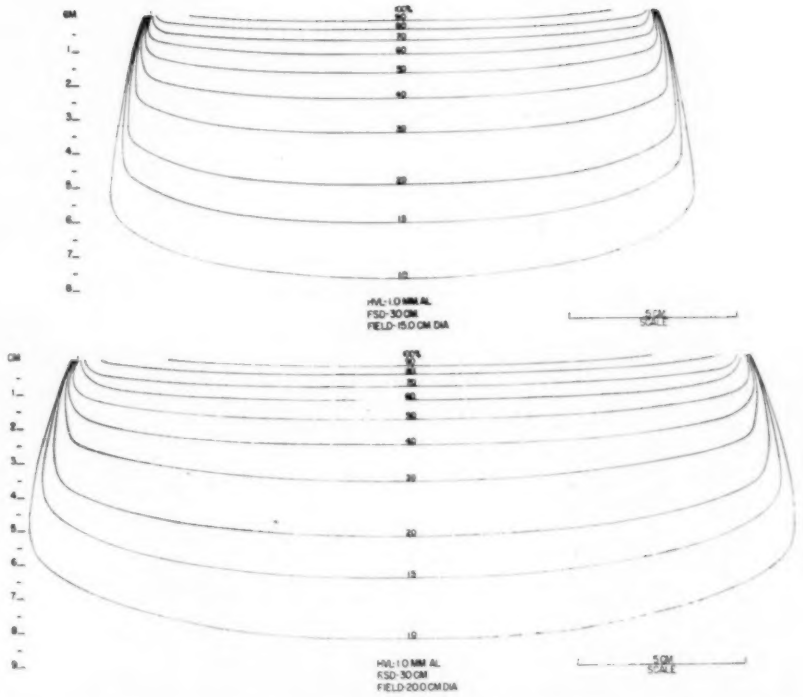



Figs. 55–56. Isodose curves, h.v.l. 0.5 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.

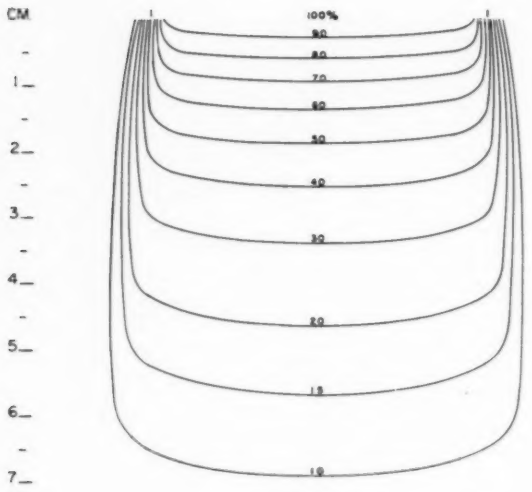


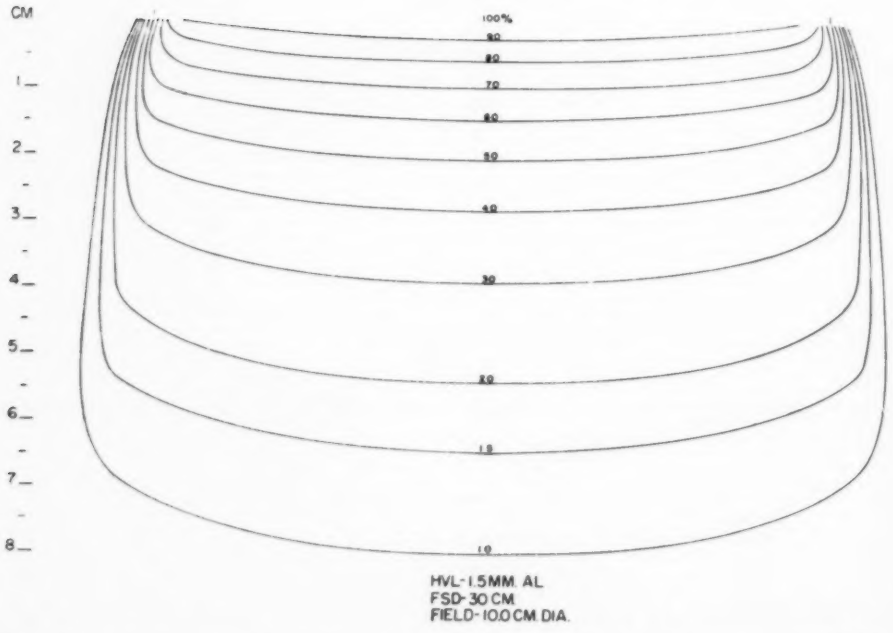




Figs. 57–58. Isodose curves, h.v.l. 1.0 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.

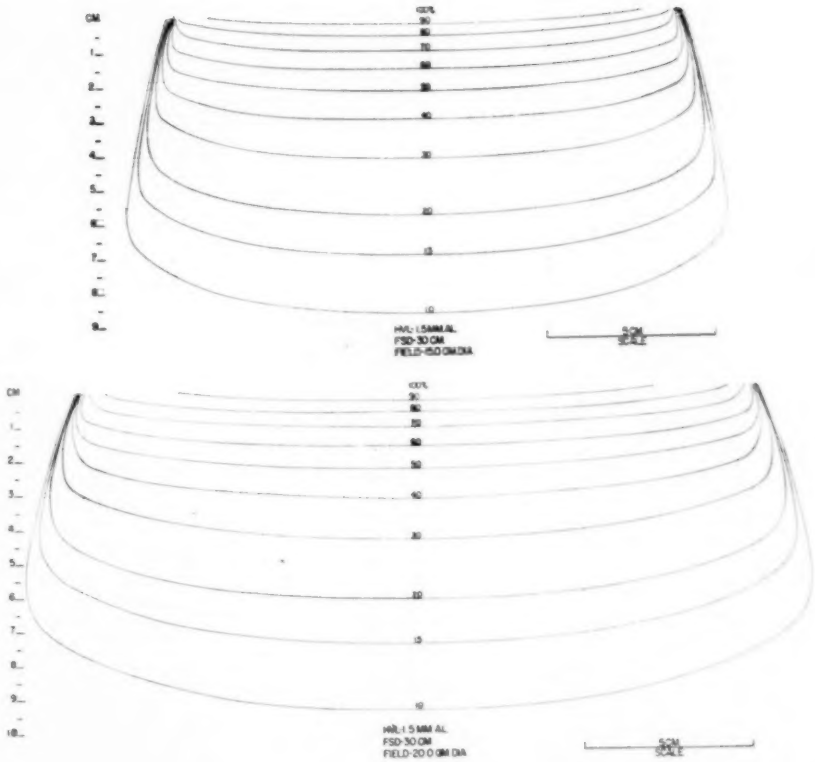



Figs. 59–60. Isodose curves, h.v.l. 1.0 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.

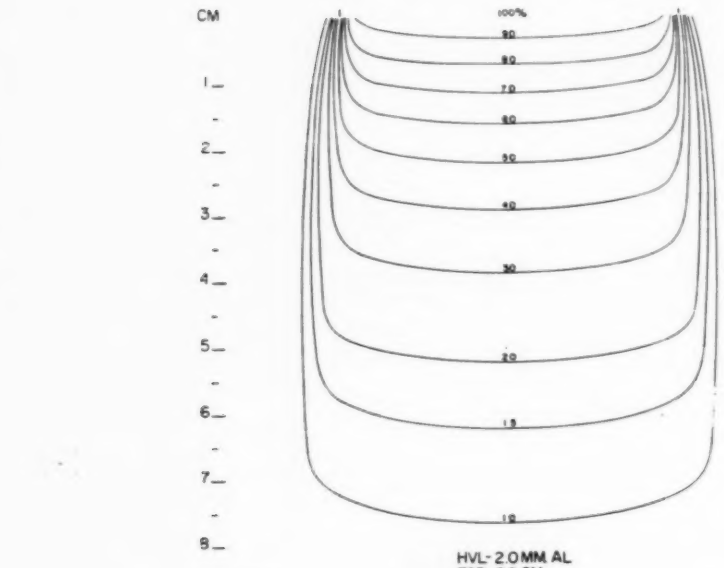


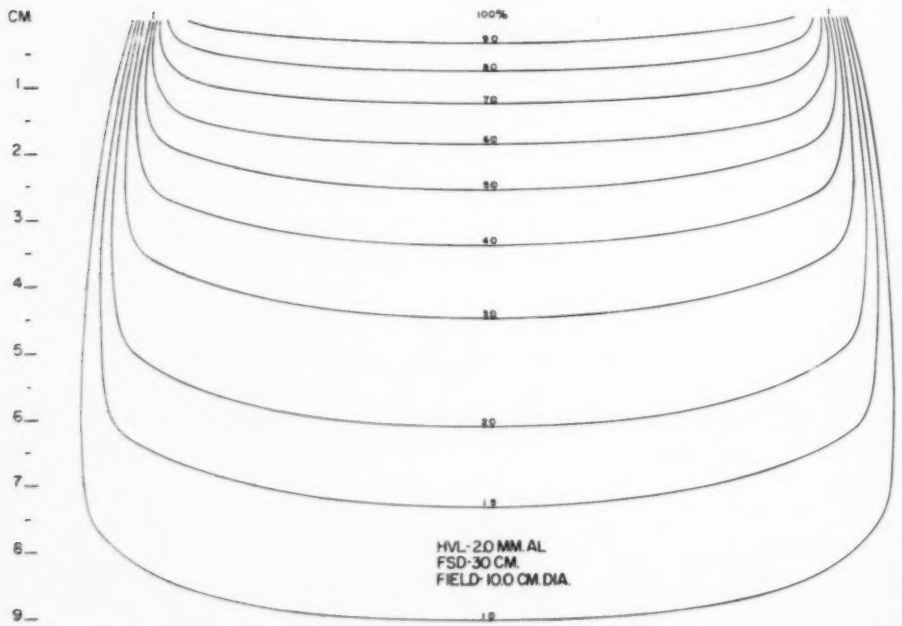




Figs. 61–62. Isodose curves, h.v.l. 1.5 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.

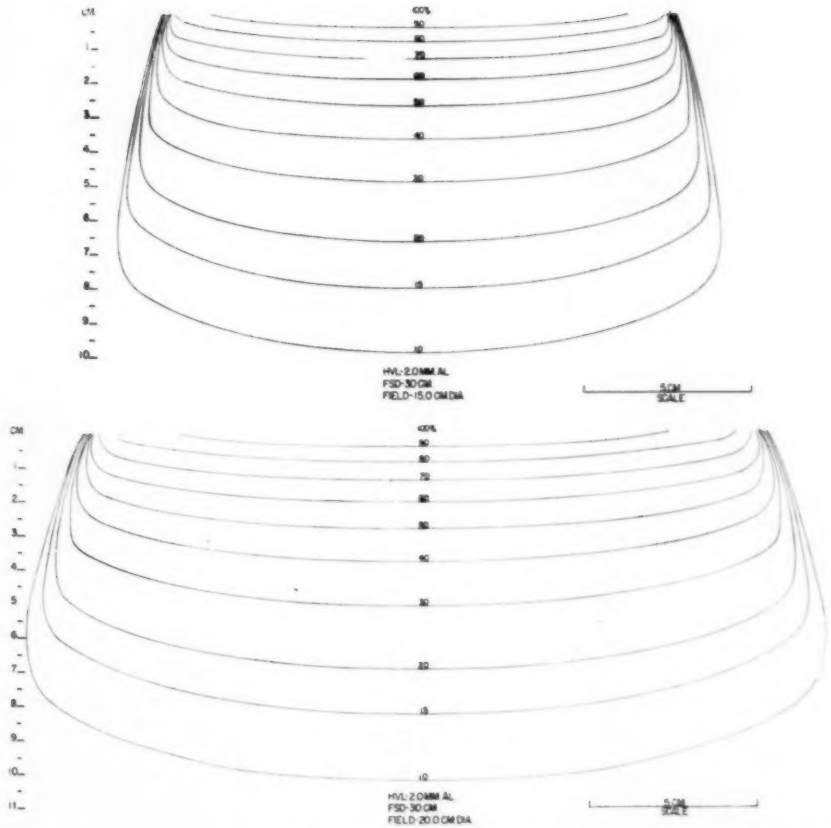



Figs. 63–64. Isodose curves, h.v.l. 1.5 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.

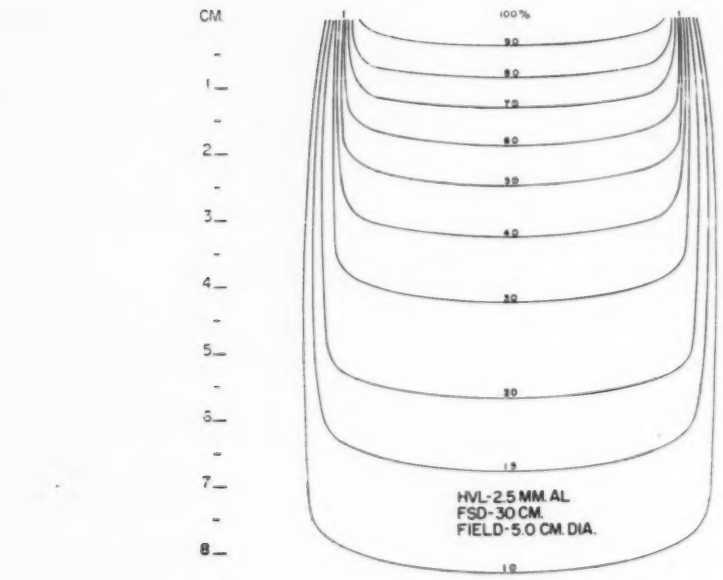


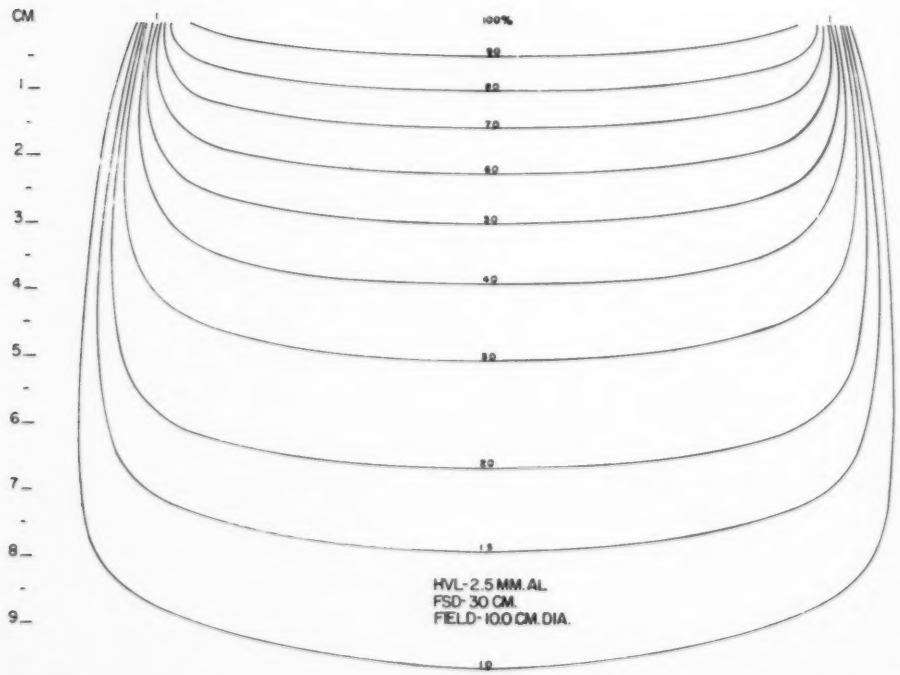




Figs. 65–66. Isodose curves, h.v.l. 2.0 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.

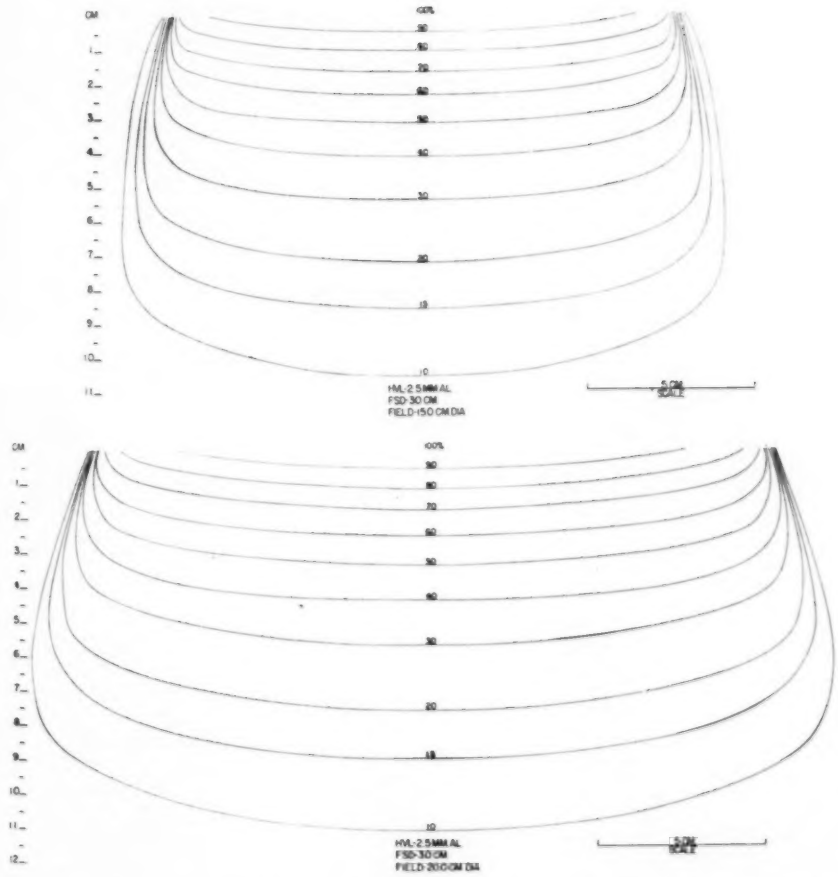



Figs. 67–68. Isodose curves, h.v.l. 2.0 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.

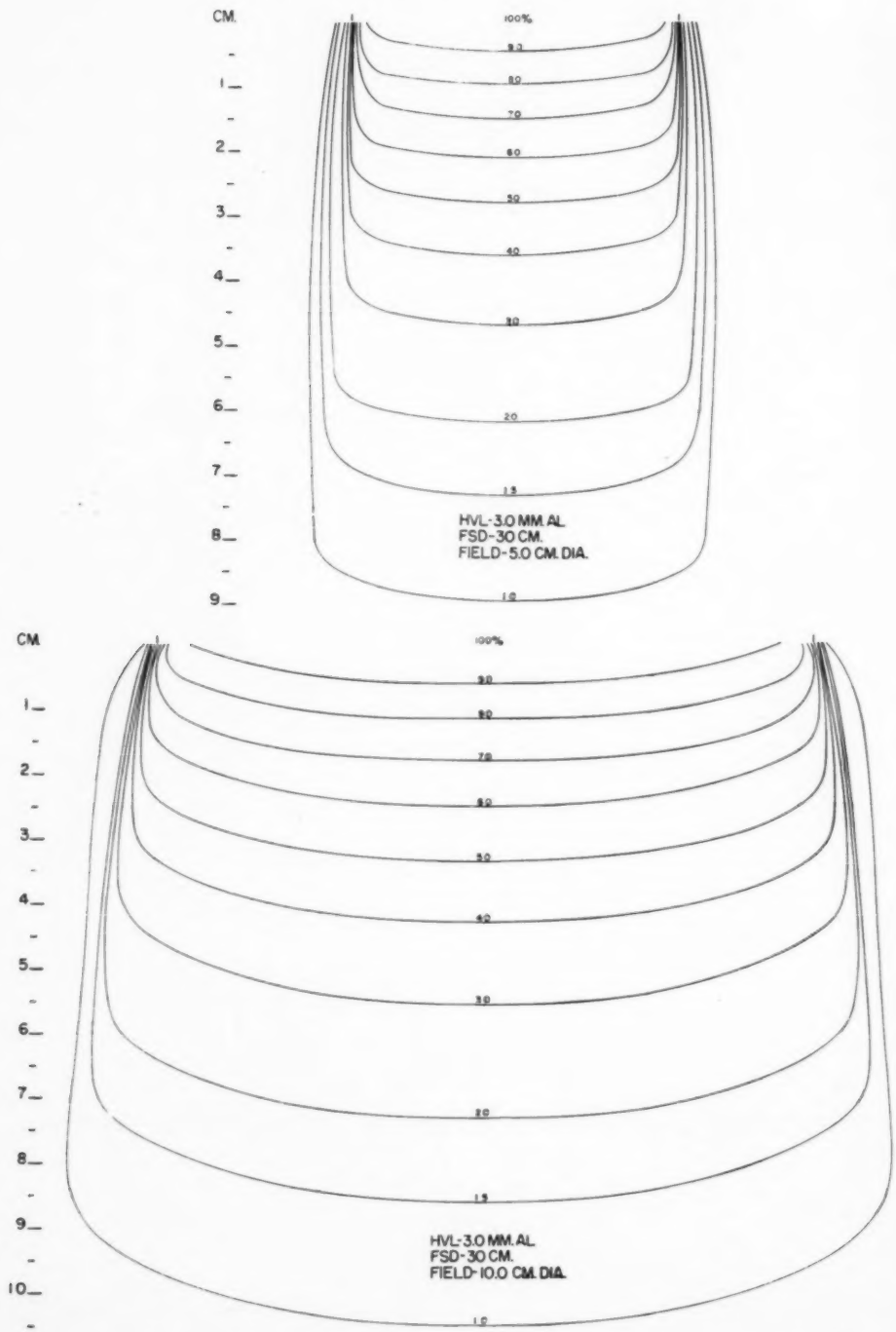


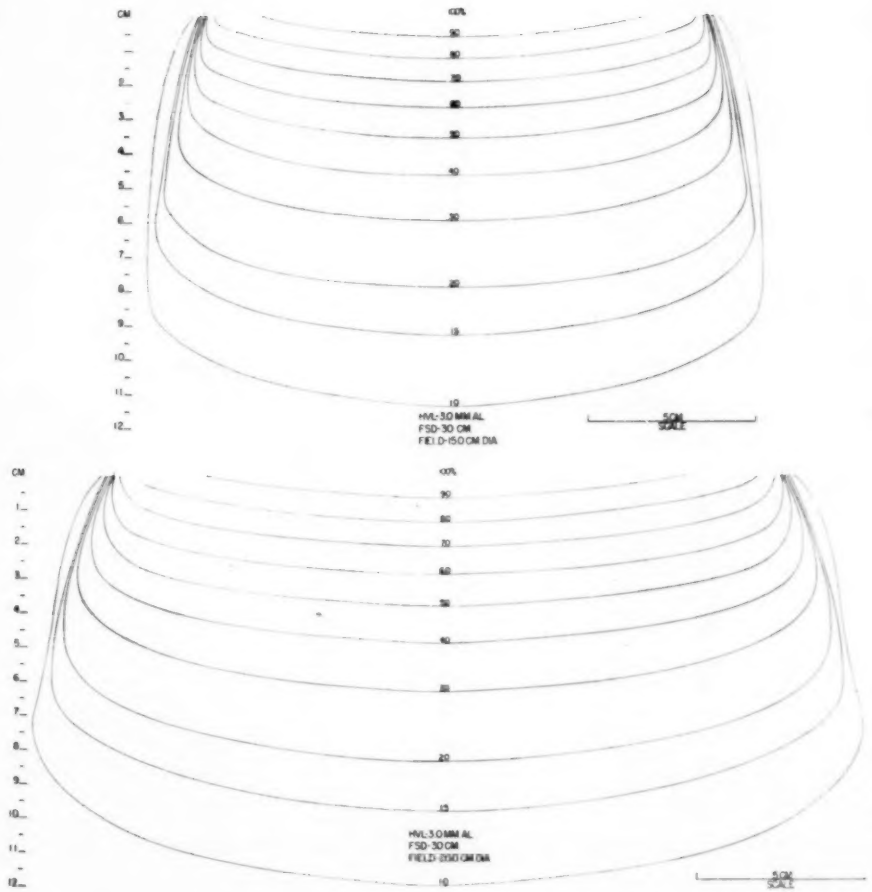

Figs. 69–70. Isodose curves, h.v.l. 2.5 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.



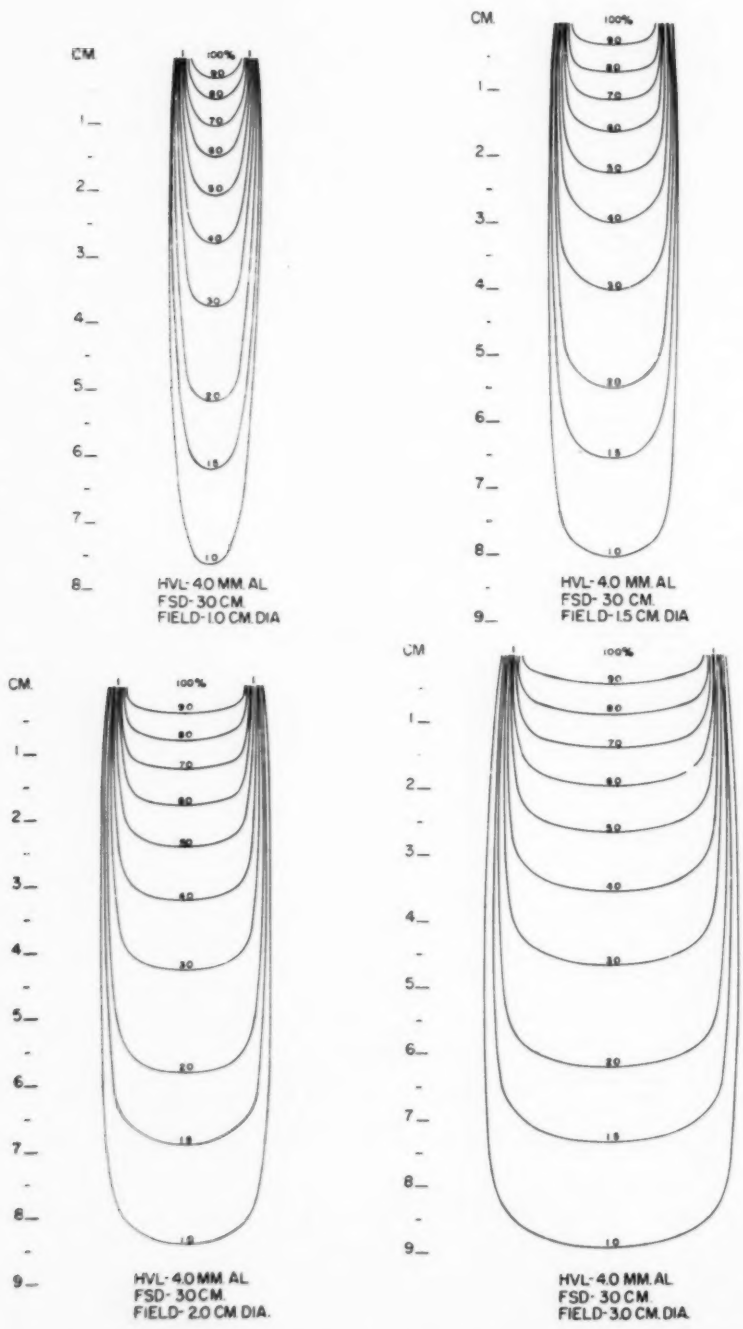

Figs. 71–72. Isodose curves, h.v.l. 2.5 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.



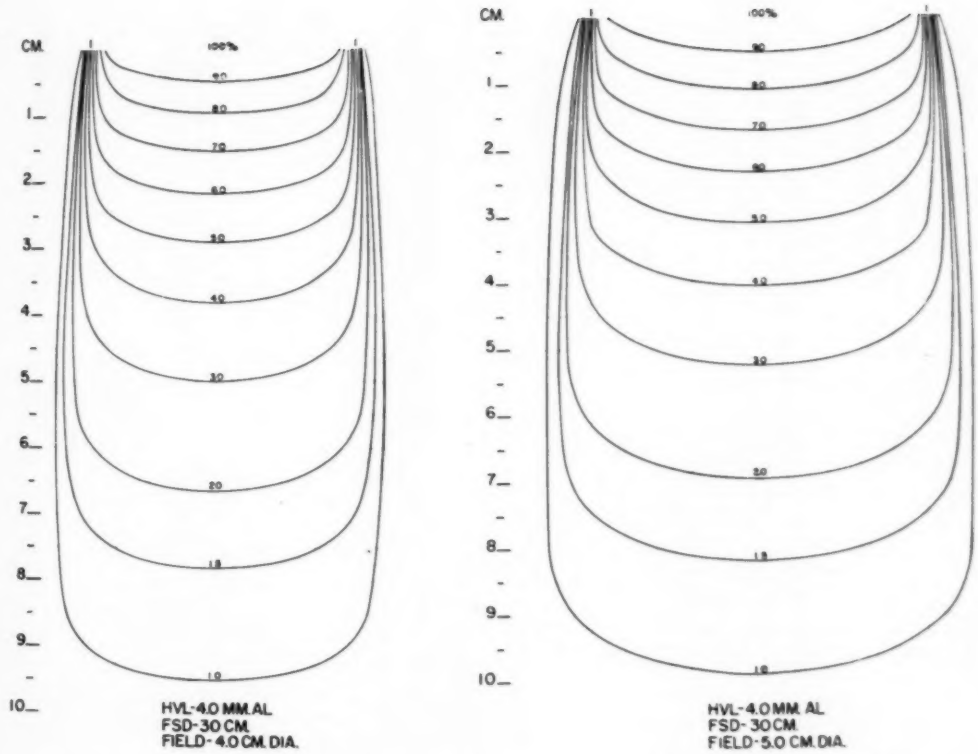

Figs. 73–74. Isodose curves, h.v.l. 3.0 mm. Al, 30 cm. F.S.D., field diameters 5.0 cm. and 10.0 cm.



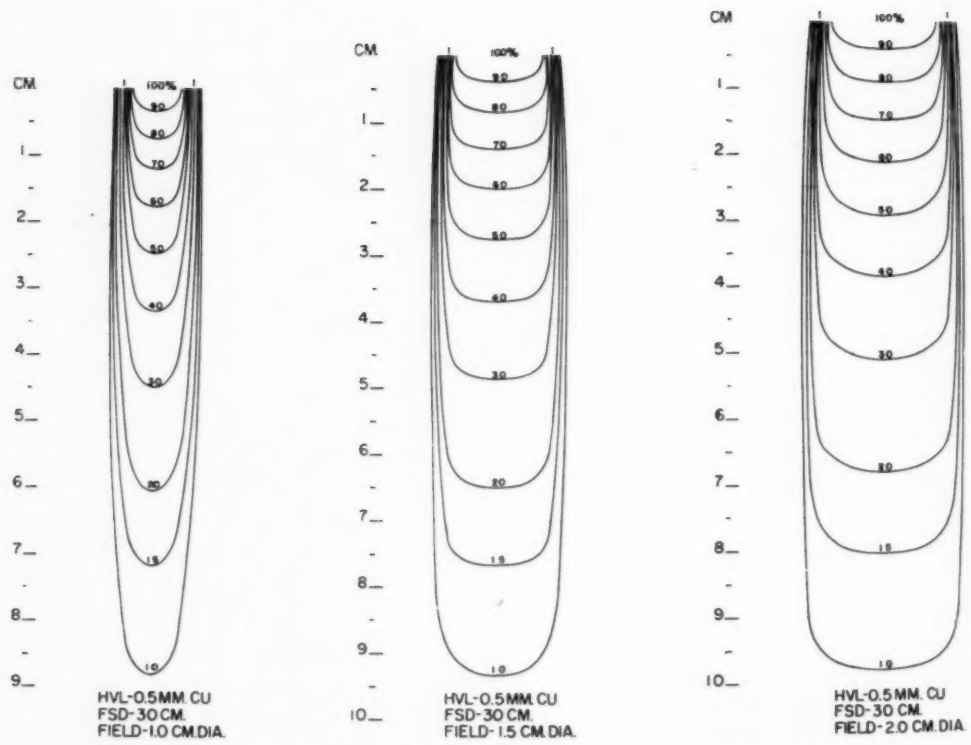

Figs. 75–76. Isodose curves, h.v.l. 3.0 mm. Al, 30 cm. F.S.D., field diameters 15 cm. and 20 cm.



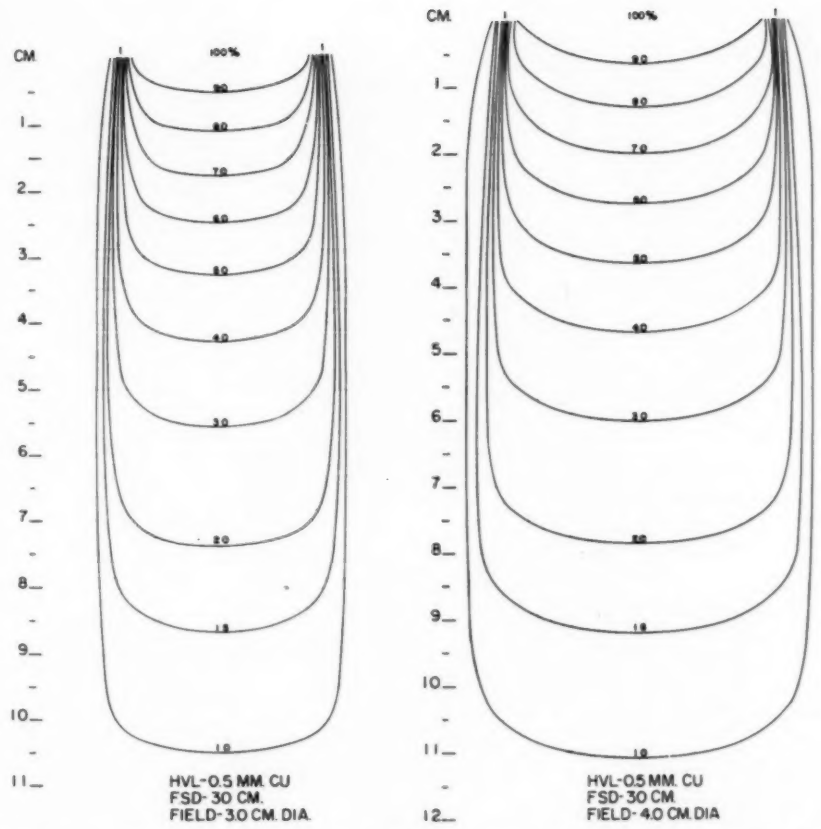

Figs. 77–80. Isodose curves, h.v.l. 4.0 mm. Al, 30 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm., 3.0 cm.




Figs. 81–82. Isodose curves, h.v.l. 4.0 mm. Al, 30 cm. F.S.D., field diameters 4.0 cm. and 5.0 cm.




Figs. 83–85. Isodose curves, h.v.l. 0.5 mm. Cu, 30 cm. F.S.D., field diameters 1.0 cm., 1.5 cm., 2.0 cm.




Figs. 86–87. Isodose curves, h.v.l. 0.5 mm. Cu, 30 cm. F.S.D., field diameters 3.0 cm. and 4.0 cm.

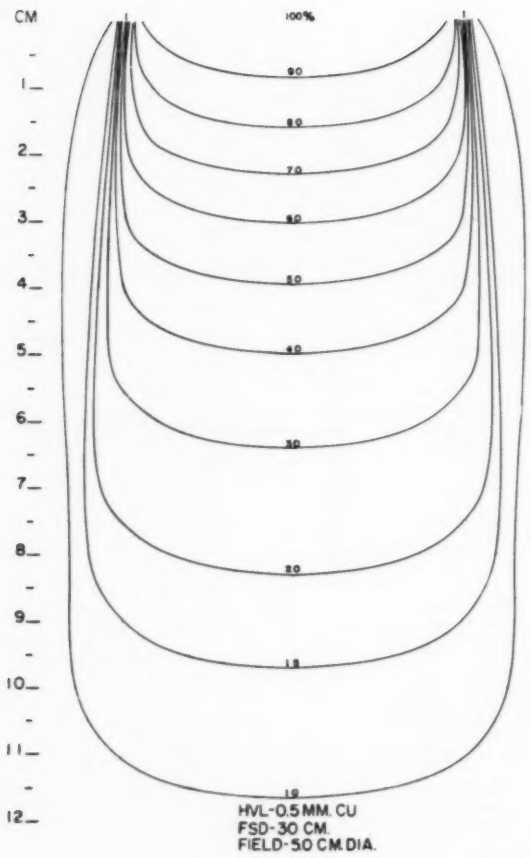



Fig. 88. Isodose curves, h.v.l. 0.5 mm. Cu, 30 cm. F.S.D., field diameter 5.0 cm.

# Roentgenologic Characteristics of the Epipericardial Fat Pad, With a Case Report[1]

JOSEPH R. NAHON, M.D.[2]

THE SMALL triangular epicardial fat pads which are so frequently seen in postero-anterior chest films at the cardiac apex, where they normally mask the blunt tip of the apex and fill in the left cardiophrenic angle, are now well known. A larger form, which may be found in the right as well as the left cardiophrenic angle, in spite of several published descriptions (1–3), is less readily identified by radiologists generally. Holt, in particular, described the roentgen characteristics of this deposit as observed in a series of probable cases. He demonstrated several conditions of pathological import closely mimicked by the epipericardial fat pad roentgenologically and stressed the importance of a differential diagnosis.

In order further to develop the roentgen features of the condition and to facilitate its recognition, we are reporting here a case of epipericardial fat pad explored first by tomography and later at thoracotomy. Relatively few such cases have been definitely identified, since this can be done only in the event of a fortuitous thoracotomy undertaken for some other reason, or on postmortem examination.

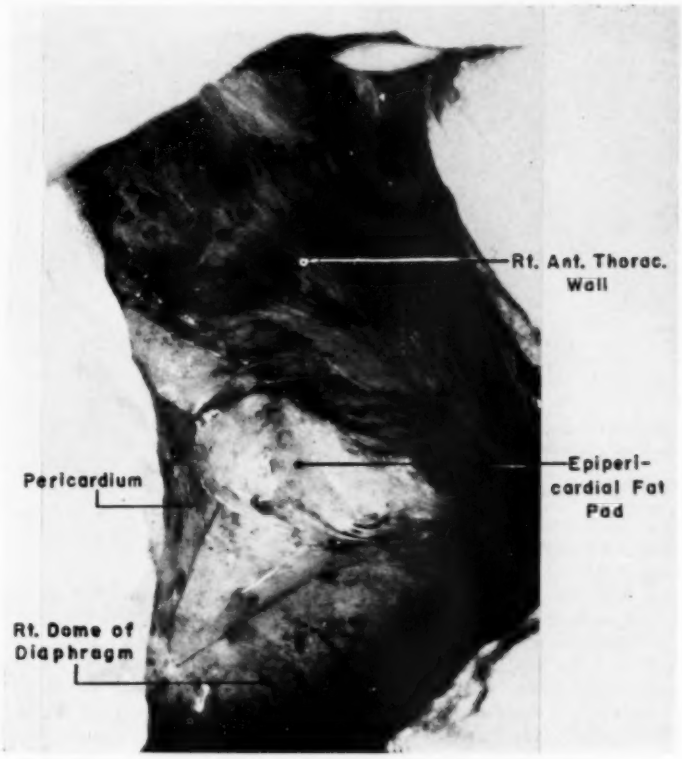



Fig. 1. View of fat pad through operative incision.

[1] Accepted for publication in November 1954.
[2] At present, Radiological Service, Veterans Administration Hospital, East Orange, N. J.

Fig. 2. Right lateral film showing triangular shadow characteristic of an epipericardial fat pad.

## CASE REPORT

A. N., a 32-year-old white male, who was discovered to have pulmonary tuberculosis with a right infraclavicular cavity on May 2, 1946, was admitted to a sanatorium on May 13, 1946, where he was treated by right pneumothorax and intrapleural pneumonolysis. He was considered "arrested" and was discharged on Dec. 3, 1946. He did well until Feb. 20, 1953, when a routine follow-up film showed a small area of fresh disease in the left apex. Following admission to a hospital, this lesion gradually resolved. Recently, x-ray examination had revealed an apparently typical tuberculoma in the right upper lung field. Tomographic examinations in July 1953, undertaken because of recurrence of positive sputum, suggested a small possible breakdown within the tuberculoma and it was decided to resect this lesion both as a possible source of the organisms in the sputum and a potential future hazard.

It was about this time that right lateral tomography clearly demonstrated a triangular shadow in the right lower anterior thorax which subsequently proved to be an epipericardial fat pad. On Dec. 28, 1953, a segmental resection of the posterior segment of the right upper lobe was performed. The surgeon, alerted to the triangular radiopacity previously described, reported it to represent an epipericardial fat pad lying in the angle formed by the diaphragm, anterior chest wall, and pericardium. A photograph of the structure through the operative incision is shown in Figure 1.

## DISCUSSION

From Holt's article, it is possible to gather some of the roentgen characteristics of large right-sided epipericardial fat pads. One feature is the presence of a smoothly rounded or lobulated shadow of soft-tissue density in the postero-anterior

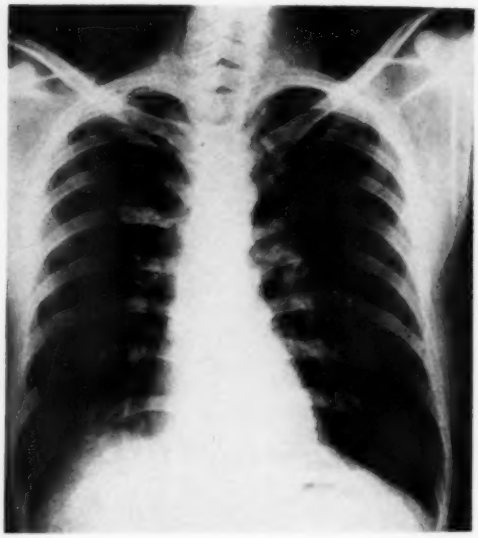


Fig. 3. Postero-anterior film showing absence of right cardiophrenic shadow.

projection, filling the right cardiophrenic angle. When such an area of density is seen, the differential diagnosis will include pericardial cyst, localized pericardial and paraspinal effusions, eventration, anomalies and tumors of the diaphragm, bronchogenic neoplasm, metastatic neoplasm, cardiospasm, atelectasis, cardiac aneurysm or neoplasm, mediastinal dermoid, neurofibrosarcoma, subpleural tuberculoma, and tracheobronchial cyst. In the lateral projection, the chief characteristic is a comparatively faintly visualized triangular shadow filling the anterior costophrenic angle and superimposed upon the anteroinferior aspect of the heart.

In the case reported here, the conven-

tional lateral film (Fig. 2) confirmed Holt's findings. In the frontal projection (Fig. 3), however, a soft-tissue mass filling the right cardiophrenic angle is noticeably absent. The most that can be said is that the contour of the diaphragmatic dome is somewhat less distinct in this location. Since so little was to be visualized in the postero-anterior view, this case was carefully explored by lateral tomography, cuts being made from 4 to 20 cm. on the right. The patient was then reversed and explored tomographically in the left lateral position. Thus, both hemithoraces were covered. From the right lateral tomographic cut number 6 (Fig. 4), it will be seen that the fat pad in question, revealed in much greater density on the tomogram, is demonstrated as a triangular structure. It is more or less a right-angled triangle, one of whose sides is along the anterior chest wall, the other along the dome of the diaphragm, while the hypotenuse, which is slightly scalloped and concave in outline, runs obliquely downward and posteriorly across the cardiac shadow. This structure is most clearly outlined in cut number 6, that is, 6 cm. mesial to the right lateral chest wall. Both lateral and proximal to this point the outline becomes less and less distinct, so that by cut number 16 the structure is scarcely visible. The investigation of the left hemithorax by tomography showed no structure resembling the pad on the right. On the tomogram, as stated above, the radiopacity of the fat

Fig. 4. Right lateral tomographic cut number 6. The triangular fat pad, its density increased in tomography, merges with the liver shadow.

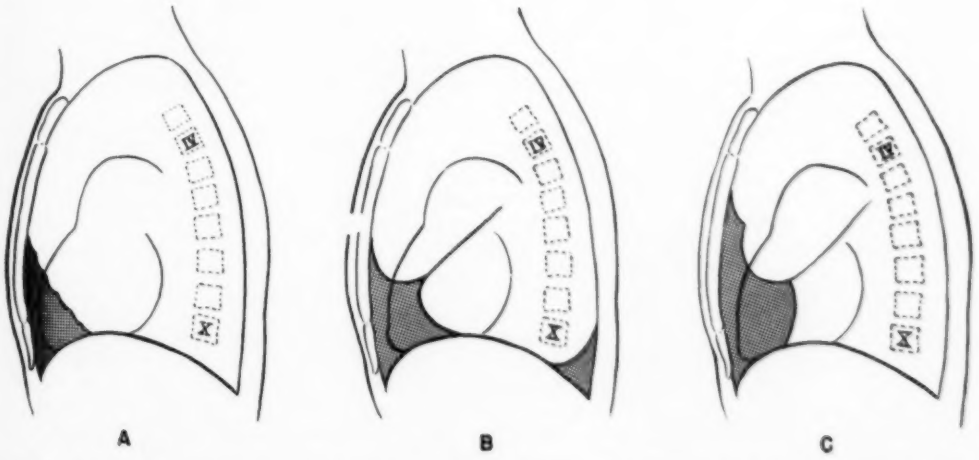



Fig. 5. Schematic drawing illustrating possible differences between, epipericardial fat pad (A), pleural effusion (B), and adhesions (C).

pad in the lateral projection appears relatively increased as compared to the conventional film, being comparable to that of the diaphragm. Diaphragm and fat pad, therefore, form one more or less continuous shadow.

The finding of such a triangular soft-tissue shadow in the anterior costophrenic angle is not uncommon; half a dozen such cases were encountered in the course of a year. In one of these, autopsy confirmed the presence of a fat pad. A limited pleural effusion and pleural adhesions both give appearances which may simulate the configuration of the epipericardial pad. Diagnostic differences are suggested in Figure 5: they are not, however, absolute. Where pleural adhesions or effusions happen to be responsible for the shadow in question, the postero-anterior projection may not show any manifestation in the cardiophrenic angle, and the differential significance which Holt has attached to such an appearance may not hold. Contrary to the observations of Cohen, none of these cases, either proved or suspected, was associated with obesity.

SUMMARY

A proved case of right epipericardial fat pad is presented. Its roentgen characteristics are elaborated and the differential diagnosis is discussed.

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SUMARIO

**Características Radiológicas del Paquete Epipericardíaco de Grasa**

Preséntase un caso comprobado de paquete adiposo epipericardíaco en el lado derecho en un enfermo examinado por virtud de una infección tuberculosa. La tomografía lateral reveló una sombra triangular en la porción inferior anterior del tórax, con un lado a lo largo de la pared anterior del tórax y uno a lo largo de la cúpula del diafragma, en tanto que la hipotenusa, que estaba ligeramente festoneada y era cóncava, seguía un curso oblicuo hacia abajo y atrás a través de la imagen cardíaca.

Pueden además producir una sombra triangular semejante un derrame pleural limitado o adherencias pleurales.

# Malignant Melanoma of the Small Intestine[1]

MICHAEL F. BEIRNE, M.D.

UNIFORMLY AS fatal as melanomas occurring elsewhere in the body, malignant melanomas of the small intestine are extremely rare. To date only about 33 of these tumors involving the gastrointestinal tract have been reported in the literature. Of these, 22 were definitely metastatic lesions, while the exact nature of some of the others remains in doubt (1). A case apparently primary in the intestine is reported here.

Fig. 1. Mucosal irregularities of the duodenum and jejunum due to the polyps.

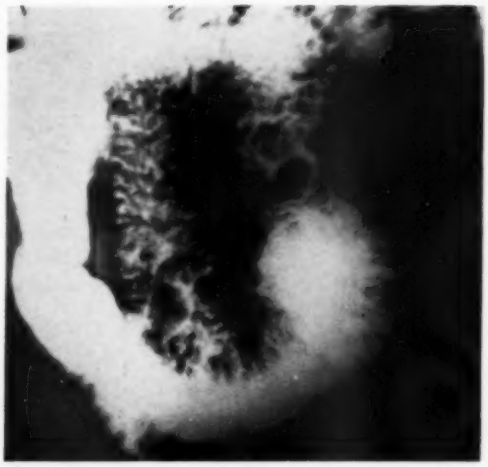

Fig. 2. Multiple filling defects in the jejunum and ileum.

## CASE REPORT

A 39-year-old white male was first seen after being under treatment elsewhere for eight months for chronic gastrointestinal bleeding, supposedly of duodenal ulcer origin. During the three months preceding admission he had lost 15 to 20 lb. of weight, had suffered from a pronounced anemia with a hemoglobin as low as 6 gm., and had received several transfusions. Occasionally he had experienced some abdominal cramps, usually mild but sometimes severe.

Tarry but well formed stools had been an almost daily occurrence since the onset of illness, and it was this sign that had brought the patient originally to his family doctor. He was the father of six children and had always enjoyed good health. The family history revealed no striking disease predilection.

On admission the patient was extremely pale but appeared well developed and "husky." No physical abnormalities were noted. Laboratory studies disclosed the following: hemoglobin 9.0 gm.; red blood cell count 3,660,000; hematocrit 28.5 per cent; white cell count 10,000, with 84 per cent polymorphonuclears, 14 per cent lymphocytes, 2 per cent mononuclears. Bleeding, coagulation, and prothrombin times were normal. The results of urinalysis were normal, as were the Kahn test, blood urea nitrogen, and fasting blood sugar.

On gastric analysis some slight increase in free acid was noted. Sigmoidoscopy revealed no lesion in the lower bowel. A chest film was negative. Gastroduodenal x-ray studies were then undertaken, but no evidence of peptic ulcer could be found. However, a deformity of the descending limb of the duodenum was observed, along with similar de-

[1] From the Department of Pathology at the Guthrie Clinic and Robert Packer Hospital, Sayre, Penna. Accepted for publication in November 1954.

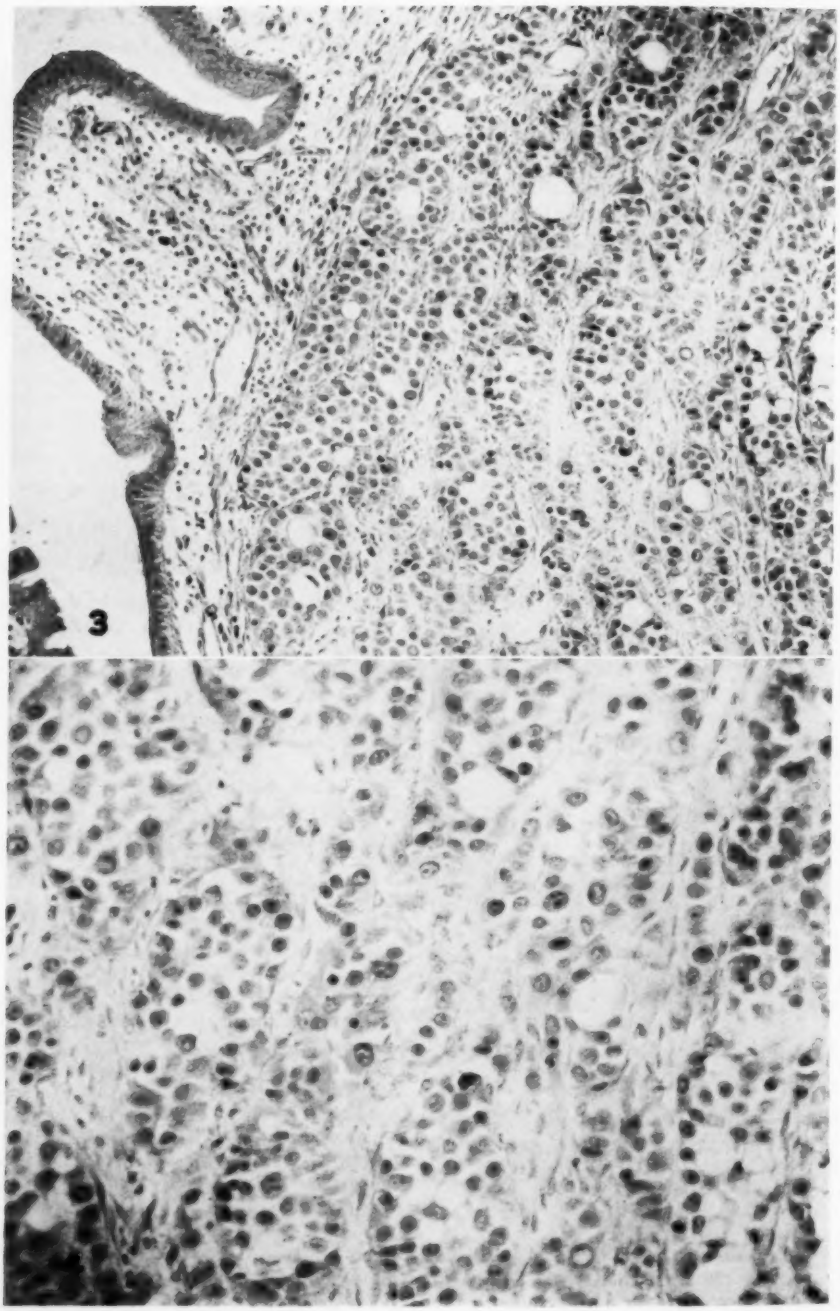


Fig. 3. Photomicrograph revealing the broad sheets of melanoma cells located in the submucosa. Note the clumps of melanin pigment.

Fig. 4. Photomicrograph illustrating the large cells, mitotic figures, double nuclei, and prominent nucleoli with an alveolar arrangement.

formities throughout the jejunum and proximal ileum. These were described as mucosal irregularities strongly suggesting multiple polyps of the small intestine (Figs. 1 and 2).

An exploratory laparotomy was done and the preoperative diagnosis was confirmed. Throughout the entire small bowel, beginning at the junction of the first and second parts of the duodenum and extending all the way to the cecum, were countless polyps varying widely in size and shape. The other viscera, including the stomach and large bowel, showed no evidence of disease. Since no curative surgical procedure could be performed, a 20-cm. portion of jejunum was resected for diagnosis and a side-to-side anastomosis was carried out to close the bowel. The post-operative course was surprisingly smooth.

The resected segment of bowel was truly remarkable. Whereas the serosal surface was smooth and glistening, the mucosa was studded with dozens of rather firm polypoid lesions of all shapes and sizes, pedunculated and sessile, ulcerated and smooth, varying in color from pink to jet black, ranging from 2 or 3 mm. up to 28 mm. in diameter. None of the polyps were fixed firmly to the muscular wall, most being mobile to a limited extent. This suggested that the lesions were all mucosal in location.

Microscopically the polyps were all similar. They were composed of broad sheets of cells, many of which were arranged in an alveolar pattern with interlacing strands of dense connective tissue (Fig. 3). Individual cells were fairly uniform in size; most had round to oval nuclei which occasionally were eccentric in position. Nucleoli and mitotic figures were not uncommon. Generous amounts of cytoplasm were present. Melanin pigment, in the form of fine granules, was definitely identified (Fig. 4). The superficial location of the tumors was again noted and microscopically they all appeared to be confined to the mucosal and submucosal region. There was no demonstrable invasion of the muscular wall of the bowel itself.

Because of the superficial resemblance that some melanomas have to carcinoid tumors (argentaffinomas) of the small bowel, both slides and wet tissue were forwarded to the Armed Forces Institute of Pathology, where our diagnosis of malignant melanoma was confirmed.

A careful search for a primary melanoma was then conducted. The skin revealed nothing even remotely suggestive, and the ophthalmoscopic examination proved equally unproductive.

Five weeks after discharge to the care of the referring physician, the patient returned to the hospital. This time a partial small bowel obstruction was in progress, and both massive emesis and melena had caused practical exsanguination. The patient was treated conservatively with suction, blood transfusions, and intravenous fluids and gradually responded, leaving the hospital after forty-three days.

A month later a large node appeared in the left inguinal area. These was resected at another hospital and proved histologically to be a metastatic melanoma.

Within another month the patient died at home. No autopsy was performed but, according to the family physician, death was preceded by bowel obstruction, massive bleeding, palpable abdominal masses, and an enlarged nodular liver. Scarcely six months had elapsed since this patient was first admitted to our hospital, and the entire disease course, including the period of initial symptomatology, had not consumed over fourteen months.

## DISCUSSION

Whether or not malignant melanomas of the intestine are primary or secondary has long been a subject of considerable debate. Some men, like Willis (2), believe that melanomas are never primary in the intestinal tract, whereas others think that, although exceedingly rare, they may occur. Suffice it to say here that, although good arguments exist both pro and con, the actual case evidence heavily favors the metastatic theory. In our patient, though the location of the tumors in the mucosal and submucosal zone strongly suggested that they might be metastatic, no primary lesion could be found.

At least three times as many anorectal melanomas have been reported as intestinal melanomas (3). Since we know that many of the anorectal lesions tend to be small and that they are often covered by normal appearing mucosa, this may provide the answer to the question of origin for the intestinal melanomas, or indeed any melanoma whose origin is not obvious after careful examination.

It is surprising that so few neoplasms may produce the same roentgenologic or gross picture. Argentaffinomas have been reported once or twice as appearing as multiple tumors of the small bowel (Ewing).

## SUMMARY

A case of malignant melanoma of the small intestine is reported, occurring in the form of multiple polyps involving the entire small intestine. Although most intestinal melanomas are metastatic, careful search in this instance failed to reveal a primary

lesion elsewhere. It would seem, therefore, that the tumor was primary in the small intestine.

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SUMARIO

**Melanoma Maligno del Intestino Delgado**

En la literatura se han descrito unos 33 melanomas malignos del tubo gastrointestinal. De ellos, se sabe que 22 eran metástasis; en los demás casos, la génesis era dudosa.

Preséntase aquí un caso en el que un melanoma maligno tomó la forma de pólipos múltiples que afectaban todo el intestino delgado. La localización de los tumores en las zonas mucosa y submucosa sugería poderosamente que tal vez fueran secundarios a una lesión de otra parte, pero no pudo descubrirse ninguna, por lo cual se presupone un origen primario en el intestino. No se ejecutó la autopsia.

# Carcinoid of the Stomach

WALTER H. CAMP, M.D.[1]

IN THE DIFFERENTIAL diagnosis of circumscribed filling defects in the stomach we usually consider such benign lesions as leiomyoma, adenomatous polyp, aberrant pancreatic tissue, and lipoma. Carcinoid of the stomach should also be included among the possibilities even in a patient who has melena.

Masson has shown that carcinoids arise from the argentaffine or Kultschitzky cells which spring from the epithelium that lines the glands of Lieberkühn (1). Ashworth and Wallace, in 1941, reviewed the literature and showed that these tumors may occur elsewhere than in the appendix and ileum, as in the colon, diverticula, stomach, gallbladder, and mesentery (2). Of the 26 cases reported in these unusual locations, 6 involved the stomach. Three of these were incidental findings at necropsy and surgery; in 1 indigestion was a presenting symptom, and in 1 there was pyloric obstruction. In no instance were the roentgen findings reported.

Wirts and Breckenridge (3) published 1 case of carcinoid of the stomach with symptoms, including in their report roentgenograms as well as an account of the gross and microscopic appearance of the tumor and the gastroscopic findings. In the literature up to that time they found only 6 cases in which symptoms and signs led to operation and diagnosis.

Christopherson also reported a case and published a roentgenogram showing a filling defect in the stomach. This patient had pain, indigestion, and other symptoms, but no melena (4).

Lützow-Holm (5) reported 2 cases, 1 with melena and the second with pain as a major symptom. Roentgenograms of both cases were published.

We have thus found, in our review of the literature, few published roentgenograms and only 10 cases with symptoms leading to operation. It has seemed desirable, therefore, to call this condition to the attention of radiologists, with a case report including the roentgenographic findings.

Fig. 1. Filling defect in the antrum.

A 52-year-old white male was admitted to the Nathan Littauer Hospital on Sept. 6, 1954, complaining of emotional stress and a gnawing sensation in the epigastrium of several months duration. Five days before admission he noted tarry stools and giddiness and weakness. There was no emesis.

The patient was well developed and well nourished but appeared apprehensive. The blood pressure was 120/70, temperature 99.4°, pulse 100, respirations 26. Physical findings were otherwise not remarkable. Laboratory findings were: hemoglobin 7.5 gm., red cell count 1,800,000, blood urea 23 mg. per 100 c.c., glucose 103 mg., serum albumin 4.4 gm., globulin 1.9 gm., total protein 6.3 gm. Urinalysis was negative. Examination of the stools was strongly positive for blood.

Roentgen studies revealed a normal esophagus and duodenal bulb. There was no evidence of esophageal varices or hiatus hernia. In the antrum of the stomach was a filling defect approximately 3 cm. in diameter. It was smoothly outlined and was demonstrable in prone, oblique, and supine

[1] From the Nathan Littauer Hospital, Gloversville, N. Y. Accepted for publication in November 1954.

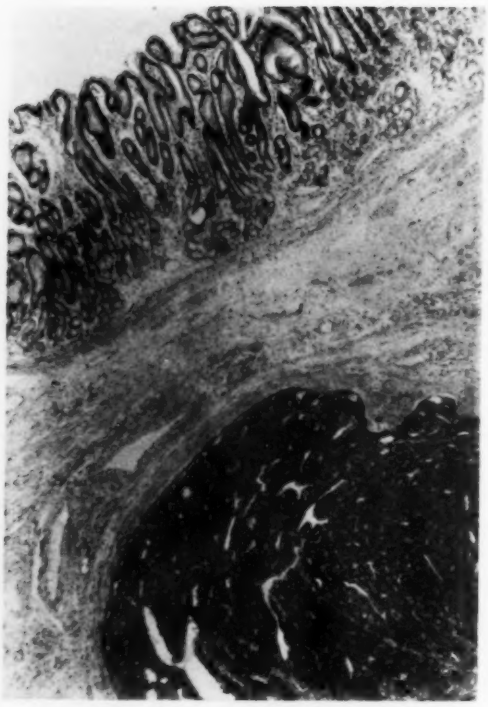

Fig. 2. Photomicrograph showing normal gastric mucosa above a well circumscribed edge of cellular tumor below.

projections. One roentgenogram showed a small collection of barium in the center of the filling defect. No stalk was demonstrated. It was felt that these findings indicated an intramural lesion with possible ulceration of the overlying mucosa. The most likely diagnosis was believed to be leiomyoma.

The patient was explored on Sept. 13, 1954. The abdomen was free of fluid. The serosa of the stomach was smooth and not involved. In the region of the antrum a smooth, well circumscribed tumor was palpable, of rubbery consistency and measuring 3.0 cm. in diameter. The antrum was opened and the mucosa over the tumor was seen to be smooth, with a small ulceration, 4 mm. in diameter. There was no evidence of metastasis. A Hofmeister subtotal gastric resection was done. Recovery was uneventful.

The gross specimen consisted of a partially resected stomach with an intramural, extramucosal tumor. The overlying mucosa was not remarkable except for a small superficial erosion. Pushing up the mucosa was a well circumscribed mass, 3 cm. in diameter, which presented in cut section a whorled, grayish pink appearance. A microscopic diagnosis of carcinoid of the stomach was made by the pathologist, Dr. R. J. Lebowich, and was confirmed by two other competent pathologists.

## SUMMARY AND CONCLUSIONS

Carcinoid tumor should be included in the differential diagnosis of smooth filling defects in the stomach. Such a tumor may produce melena due to ulceration of the overlying mucosa. A case is presented.

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## SUMARIO

### Carcinoide del Estómago

El carcinoide debe recibir consideración en el diagnóstico diferencial de los nichos circunscritos del estómago. Aunque esas lesiones quizás sean asintomáticas, también pueden presentar síntomas, comprendiendo melena debida a ulceración de la mucosa sobreyacente.

Preséntase un caso en un enfermo que se quejaba de heces embreadas, de una sensación de roedura en el epigastrio y de debilidad. Las radiografías revelaron un nicho en el antro gástrico, en cuyo centro podía observarse una pequeña acumulación de bario. Se emprendió la operación y se hizo un diagnóstico microscópico de carcinoide.

# Collateral Circulation of the External Carotid Artery and the Internal Carotid Artery through the Ophthalmic Artery in Cases of Internal Carotid Artery Thrombosis

## Report of Five Cases[1]

PAUL M. LIN, M.D., and MICHAEL SCOTT, M.D.

Occlusion or thrombosis of the internal carotid artery in the neck is being recognized more frequently. Gross (2), Johnson and Walker (4), and others have described this condition and all stress the importance of angiographic findings in diagnosis. Gurdjian and Webster (3) pointed out, in addition, the value of intraoral palpation of the artery in establishing the occlusion. Exploration of the internal carotid artery in the neck and, if feasible, section of the vessel offer the definitive diagnosis.

It is known that in internal carotid artery occlusion, the defective cerebral circulation can be improved by collateral circulation through the circle of Willis. If this latter circulation is inadequate, due to under-development of the anterior and the posterior communicating artery, collateral circulation can be established through anastomosis of the branches of the external carotid artery, mainly the internal maxillary artery and the facial artery, with the ophthalmic artery. Marx (6) was the first to report the angiographic demonstration of such collateral circulation in 2 cases of internal carotid artery occlusion.

Strully (8) and associates have recently published a case of internal carotid artery thrombosis which was verified by angiographic evidence of complete collateral circulation from the opposite internal carotid artery through the anterior communicating artery and by exposure of the vessel in the neck. Other routes of collateral circulation have been reported by various authors. Richter (7) recently described 2 cases of collateral circulation *via* the occipital branch of the external carotid artery and the muscular branches of the vertebral artery. Takahashi (9), in 1940, reported a case of thrombosis of both internal carotid arteries, in which filling of the carotid system was obtained by vertebral injection.

We have recently studied 5 cases of internal carotid artery occlusion in which a definite diagnosis was established by angiographic demonstration of anastomosis of the external carotid artery and the internal carotid artery above the site of occlusion, through the retrograde circulation in the ophthalmic artery of the same side.

### CASE REPORTS

Case I: S. D., male, age 72, was admitted to Temple University Hospital (service of Dr. L. Soloff) on July 25, 1952. He had been well until three weeks prior to admission, when he became irritable and insomnia developed. On admission, he appeared alert but exhibited jargon speech. There was no papilledema, and the neurologic examination was negative. Spinal puncture revealed xanthochromic fluid with a pressure of 110 mm. of water. Spinal fluid protein was 47 mg. per cent, with 1 white blood cell. Speech improved gradually in ten days.

On Aug. 6, left carotid angiography was performed by the biplane stereoscopic technic. Filling of the external carotid artery and its branches was demonstrated, but there was no intracranial filling *via* the internal carotid artery on the left side (Fig 1A). However, retrograde passage of contrast medium into the carotid siphon and then into the anterior and middle cerebral arteries was obtained by way of the ophthalmic artery (Fig. 1B). This retrograde flow from the external carotid system through the ophthalmic artery into the internal carotid is postulated on the basis of the internal carotid artery thrombosis and subsequent decrease in the pressure in the internal carotid artery system.

The patient was discharged with minimal speech difficulty.

Case II: J. K., male, age 36, was first admitted to Temple University Hospital (service of Dr. Gilpin)

[1] From the Department of Neurosurgery, Temple University Hospital and School of Medicine, and Albert Einstein Medical Center, Northern Division, Philadelphia, Penna. Accepted for publication in October 1954.

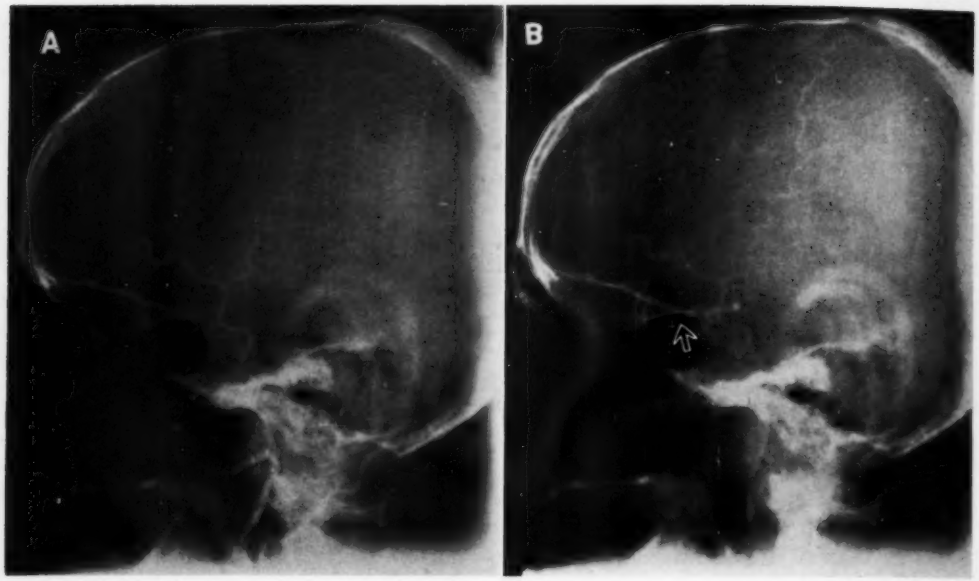


Fig. 1. Case I.

A. Lateral view of the early arterial phase in a case of internal carotid artery thrombosis. Note the absence of filling of the internal carotid artery.

B. Lateral view of the later arterial phase. The arrow indicates the retrograde filling of the internal carotid artery from the ophthalmic artery. The internal carotid artery is not visualized below the siphon.

on April 6, 1953. He had been apparently well until a month earlier, when he experienced sudden onset of headache, dizziness, staggering gait, and vomiting. In a day or two, speech difficulty developed. His wife noticed a marked personality change and mental deterioration.

Two years before admission the patient had an episode of transitory weakness and numbness in the right hand, but neurologic examination and studies done at that time were negative. He was quiet and showed no interest in questioning. He appeared schizophrenic, with intellectual deterioration. Speech was scanning and dysarthric. The pupils were equal and reactive. There was no ocular weakness. The fundus showed no papilledema. Slight nuchal rigidity was present, and the superficial temporal and supra-orbital arteries were abnormally prominent. There was no motor weakness or loss of sensation. Moderate ataxia was present on finger-to-nose and heel-to-knee tests and on walking. Blood pressure was 150/100. Spinal fluid pressure was 158 mm. of water, with normal chemistry and cell count.

The patient's condition fluctuated considerably. The temperature ranged between 99 and 101° F., and the pulse rate between 90 and 120, for three weeks after admission. Because of the sudden onset, temperature elevation, and diffuse cerebral involvement, the possibility of various vascular conditions, as well as encephalitis, multiple sclerosis, and tumor, was considered.

On April 16, a left percutaneous carotid angiogram was considered. Palpation over the left common carotid artery showed no arterial pulsation, however, and for that reason a right percutaneous carotid angiogram was obtained (Fig. 2A). This revealed an unusually large external carotid artery and no internal carotid artery in the neck; also, an unusually large internal maxillary and superficial temporal artery. The choroid plexus of the right eyeball was well visualized and from it the ophthalmic artery was filled with the medium, which also filled the most distal portion of the internal carotid artery as far as the level of the cavernous sinus but not below it. The anterior and middle cerebral arteries were well filled on this side. There was bilateral filling of the anterior cerebral artery, presumably because of the slow rate of blood flow due to the occlusion of the left internal carotid artery.

Exploration of the left common carotid artery was done the next day under cervical block anesthesia. This artery was found to be very small. Pulsation, as determined by direct palpation, was only one-quarter of the strength of pulsation on the right side. The left internal carotid artery was small and fibrotic. Open left carotid angiography was performed through injection of the common carotid artery, with findings (Fig. 2B) essentially the same

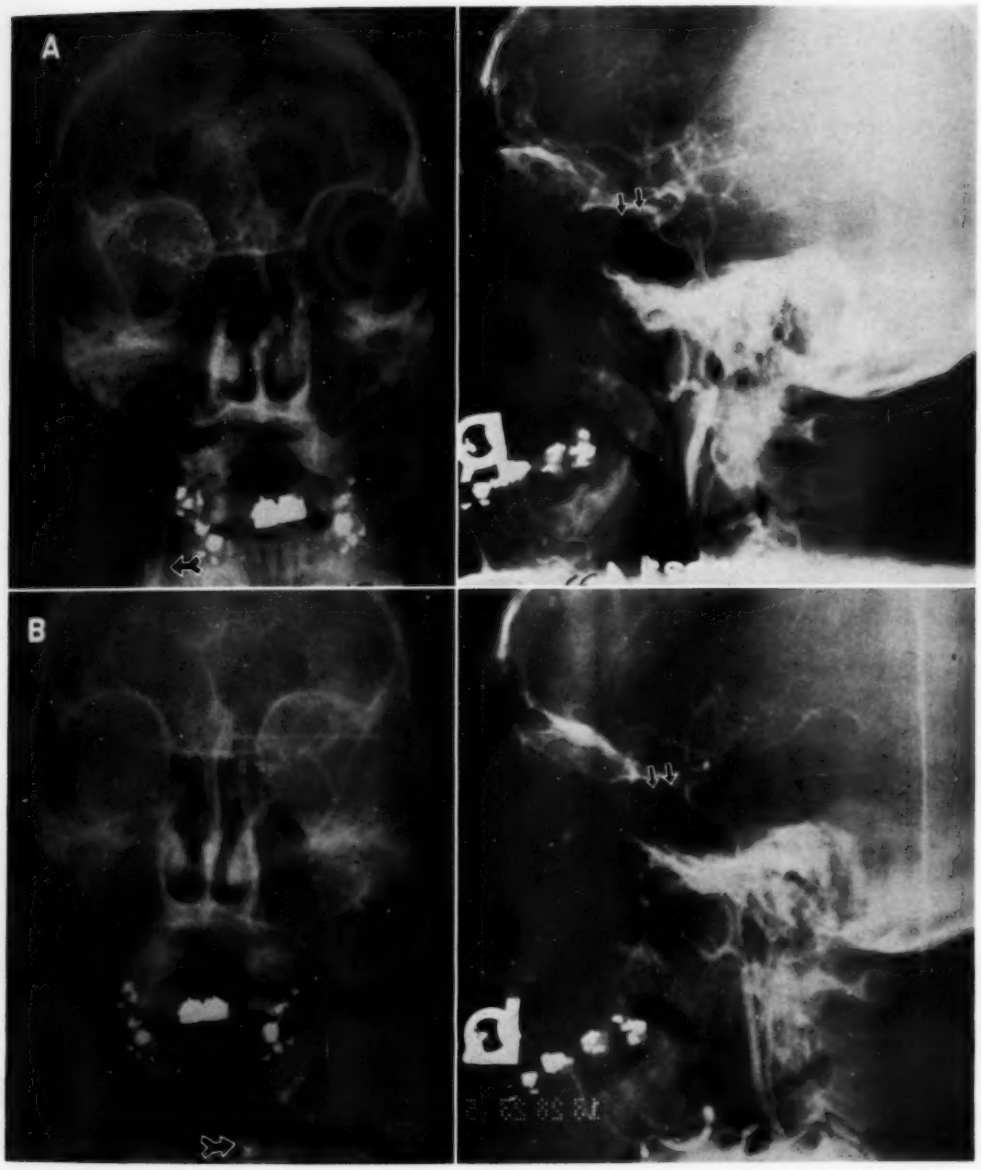


Fig. 2. Case II: Bilateral occlusion of the internal carotid arteries.

A. The right carotid angiogram (anteroposterior and lateral views) shows that the internal carotid artery and its branches above the sella have been filled by way of the ophthalmic artery (arrows in lateral view). The arrow in the anteroposterior view shows the bifurcation of the common carotid artery where the internal carotid artery is not visualized between the bifurcation and the siphon.

B. Left anteroposterior and lateral angiogram showing anastomosis of ophthalmic artery with the internal carotid artery, similar to that shown by the angiogram on the right side (A).

as on the opposite side (Fig. 2A). A large external carotid artery was demonstrated, with a large internal maxillary artery and a very large meningeal branch which crossed the greater wing of the sphenoid in the posterior orbital wall and, subsequently, appeared to anastomose with some of the branches

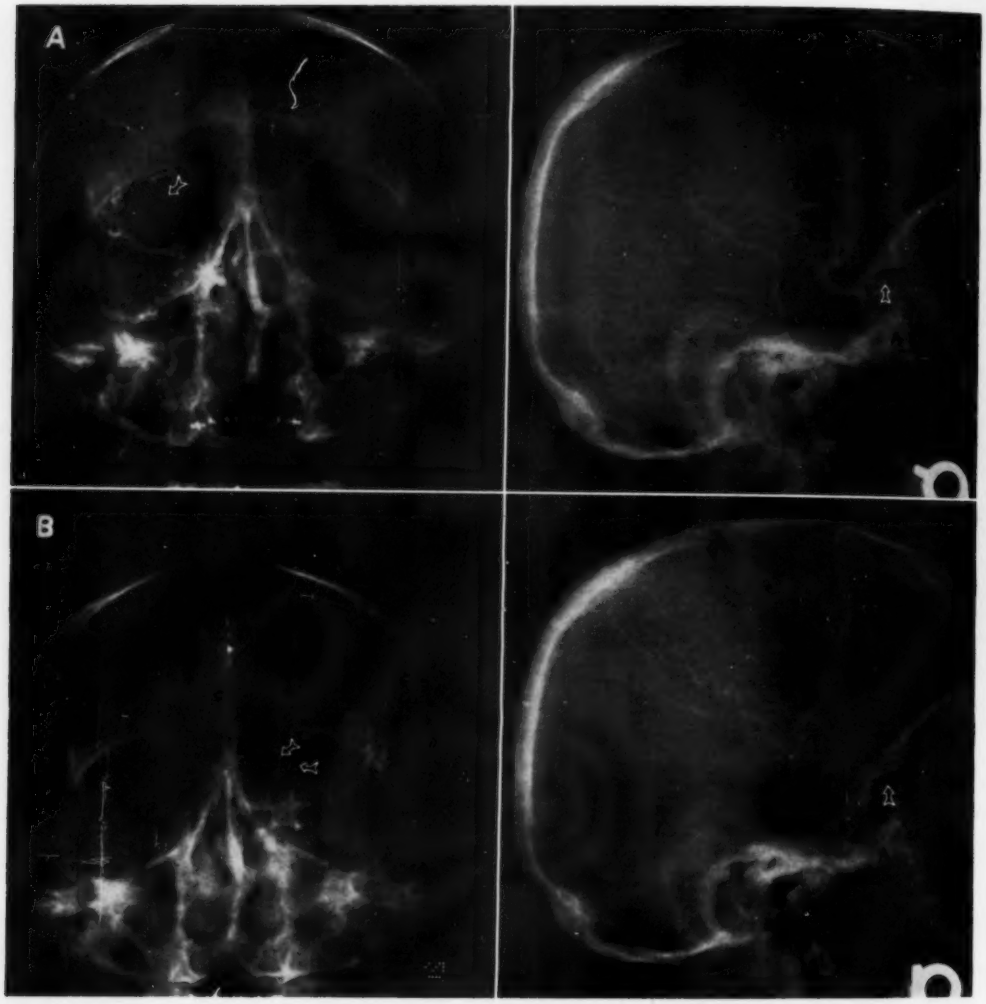


Fig. 3. Case III: Bilateral internal carotid artery thrombosis.

A. Right carotid angiogram (anteroposterior and lateral views). The arrow in the lateral view indicates the ophthalmic artery, which receives the collateral circulation from branches of the internal maxillary artery (A). The anteroposterior view shows the supraorbital artery receiving its collateral circulation from a branch of the superficial temporal artery (arrow).

B. Left anteroposterior and lateral angiogram. The demonstration of collateral circulation of the external carotid artery and the intracranial portion of the internal carotid artery through the ophthalmic artery is identical with the right carotid angiogram.

of the middle cerebral artery in the region of the insula. The ophthalmic artery was smaller in caliber on the left side than on the right side, but again it was responsible for filling of the distal portion of the internal carotid artery as far as the cavernous sinus. The middle and posterior cerebral arteries on the left side were also well filled.

Following the above procedure, the patient became comatose, with complete flaccidity of the extremities. The sudden change of condition after the carotid artery exposure was attributed to decompensation of the already embarrassed cerebral circulation, probably due to manipulation of the artery and irritation by the contrast medium. The angiographic studies showed occlusion of the major portion of both internal carotid arteries. Most of the cerebral blood supply was apparently obtained through the ophthalmic arteries *via* the collateral circulation of the branches of the external carotid artery.

The etiology of the occlusion in this young patient

has not been determined. It might have been congenital or due to thrombosis or inflammation. There was no systemic evidence of Buerger's disease, periarteritis nodosa, or arteritis. The patient recovered slowly and was able to walk one month after angiography. He had difficulty with speech, however, and showed marked mental retardation.

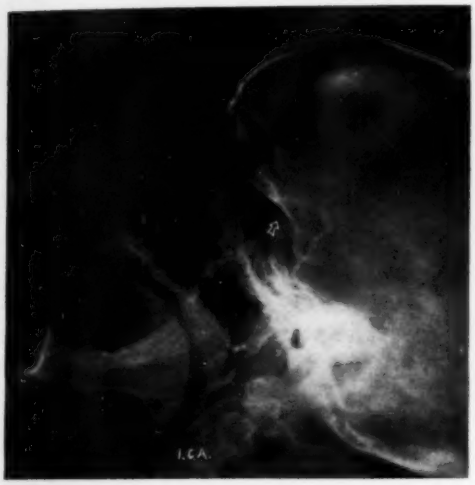


Fig. 4. Case IV. Right lateral carotid angiogram in a case of internal carotid artery occlusion. I.C.A. indicates the stump of the internal carotid artery in the neck. The arrow points to the ophthalmic artery, which anastomoses the external carotid artery with the intracranial portion of the internal carotid artery.

Case III: A. W., male, age 59, was admitted to the service of Dr. M. Scott on Dec. 30, 1954, with generalized weakness, difficulty in speech, and alternating right and left hemiparesis of five weeks duration.

The patient was slightly confused. Pupils were equal and reactive. Fundi showed changes of chronic hypertension. A constant horizontal and rotary nystagmus in all directions was present. The deep tendon reflexes were hyperactive bilaterally, with abortive clonus and a positive Babinski sign. Sensation was normal. There was a slight ataxia in both upper extremities. In short, the clinical picture was that of diffuse bilateral involvement, supratentorially and infratentorially.

Spinal tap showed a pressure of 240 mm. of water with 100 to 200 white blood cells and a protein of 131 mg. per cent.

X-ray examination of the skull revealed slight demineralization of the posterior clinoid processes.

On Jan. 4, 1955, right carotid angiography showed failure of visualization of the right internal carotid artery (Fig. 3A) in the neck. In the middle and late arterial phases, numerous small ascending anastomotic branches (Fig. 3A) arising from the internal maxillary artery anastomosed with the right ophthalmic artery in the choroid plexus of the orbit. The ophthalmic artery drained into the siphon of the internal carotid artery, which divided into the right anterior and middle cerebral arteries. On the anteroposterior projection, branches of the superficial temporal artery could be seen clearly (see arrow in Fig. 3A), anastomosing with the right ophthalmic artery through its branches, the supraorbital and supratrochlear arteries. The internal carotid artery was not visualized below the siphon. The complete arterial phase took six seconds, which is unusually long as compared with the normal of two to three seconds. The left carotid angiogram showed an identical picture (Fig. 3B).

Fig. 5. Case IV. Left anteroposterior carotid angiogram in the case of right internal carotid artery occlusion shown in Fig. 4. Anterior and middle cerebral arteries on both sides are filled.

CASE IV: P. F., male, age 57, was admitted to the service of Dr. A. Green on Dec. 27, 1954, with headache and swelling, tingling and weakness of the left hand of two months duration. The patient had a mild hypertension (150/80). Neurologic examination revealed some weakness and trophic changes in the affected hand. X-ray examination of the skull was negative.

Right carotid angiography on Jan. 3, 1955, showed the right internal carotid artery in the neck as a short, tapering stump; the medium stopped abruptly 1 inch above the bifurcation of the common carotid (Fig. 4, I.C.A.). A prominent ophthalmic artery (Fig. 4, arrow) was demonstrated, receiving its arterial blood from collateral circulation of branches

of the external carotid artery. The ophthalmic artery drained into the siphon of the internal carotid, and only the posterior cerebral artery could be seen branching from the intracranial portion of that vessel.

The angiographic findings unequivocally suggested occlusion of the right internal carotid artery. The absence of a left hemiplegia could be explained by an adequate collateral circulation to the right cerebral hemisphere from the carotid artery of the opposite side or, less likely, the right vertebral artery. This supposition was verified by a left carotid angiogram (Fig. 5), which showed that the anterior and middle cerebral arteries of both sides were filled by the left internal carotid artery. This finding further supported the angiographic diagnosis of right internal carotid artery thrombosis.

CASE V: J. H., a 70-year-old colored man, was admitted to Temple University Hospital, disoriented and unable to speak. His family stated that when he awoke on the morning of admission he was unable to move or to recognize anyone. One year prior to admission he had undergone amputation of the right leg because of arteriosclerosis.

Examination showed a semi-comatose patient with a blood pressure of 70/40. The pupils were constricted. The corneal reflex was decreased on the left. There was a hypoactive gag reflex. Deep tendon reflexes were depressed and flaccid weakness was present in all extremities.

A cerebrovascular accident was suspected. Spinal puncture yielded a clear cerebrospinal fluid, with a pressure of 180 mm. A percutaneous angiogram on the right side revealed no filling of the internal carotid artery. The external carotid artery was well visualized. In late arterial phase, the ophthalmic artery was seen within the orbit, entering intracranially into the siphon and filling the right posterior cerebral artery. This finding suggested the diagnosis of thrombosis of the internal carotid artery.

Exploration of the carotid artery in the neck was considered, but the patient's condition suddenly became worse and he died eleven days after admission. Autopsy was refused.

## DISCUSSION

The diagnosis of internal carotid artery occlusion based solely on angiographic evidence of failure of the vessel to fill with the contrast medium is subject to possible error. Various factors can influence this failure to fill:

1. Placement of the needle close to the bifurcation of the common carotid artery or with the bevel facing the external carotid artery may channel the major portion of the medium into the external carotid system. If the bifurcation of the common carotid artery is lower than normal, the needle may be inserted into the external carotid artery or one of its branches.

2. The internal carotid artery may go into temporary spasm as a result of irritation by the contrast substance, multiple punctures, or some intrinsic condition such as arteriosclerosis or arteritis.

3. It has been our experience that a space-occupying lesion in the middle fossa can cause unsatisfactory filling of the internal carotid artery. This can be due to pressure of the tumor on the artery as it enters the cranium.

To establish a definite diagnosis of internal carotid artery occlusion, one must often resort to exposure of the vessel in the neck. However, the obstruction may sometimes be higher than the site of exposure and thus escape detection. We believe, therefore, that when an occlusion of the internal carotid artery is suggested by a carotid angiogram, one should try to establish the presence of a collateral circulation from the opposite internal carotid artery and from the vertebral artery by carotid angiography on the opposite side, followed by vertebral angiography if necessary. This not only helps in the diagnosis of the occlusion but also is an aid to prognosis.

Normally, the blood in the artery does not flow backward in the ophthalmic artery unless there is a diminishing pressure in the internal carotid artery. Therefore, visualization of the ophthalmic artery through its choroidal plexus, anastomosing with the branches of the external carotid artery (in the absence of visualization of the internal carotid artery above the common carotid bifurcation), is a good indication of internal carotid occlusion proximal to the ophthalmic artery.

It is interesting that extremely prominent superficial temporal arteries were seen in both cases (Cases II and III) of bilateral occlusion of the internal carotid artery reported above. This finding may prove to be one of the signs of collateral circulation in such lesions.

Except for Case IV, all the carotid angiographic studies were done on Chamberlain's biplane stereoscopic angiographic unit (1). We believe that serial carotid angiography helps in recognizing the collateral circulation through the ophthalmic artery in these cases, as the retrograde filling of the ophthalmic artery does not appear until in the late arterial phase, usually two to four seconds after the injection. Stereoscopy aids in identifying the ophthalmic artery, especially in the anteroposterior projection.

## CONCLUSION

In making a diagnosis of internal carotid artery occlusion or thrombosis by angiography, one must rule out other cerebral lesions by air study, unless the internal carotid thrombosis (occlusion) can be verified by operation, or by evidence of collateral circulation either through the opposite carotid or vertebral artery or by way of the external carotid artery through the ophthalmic, middle meningeal or muscular branches of the vertebral artery on the same side. Collateral circulation of this latter type, in the absence of filling of the internal carotid artery above the bifurcation of the common carotid artery, is described as a pathognomonic angiographic sign of occlusion of the internal carotid artery.

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## SUMARIO

### Circulación Colateral de la Carótida Externa y la Carótida Interna a Través de la Arteria Oftálmica en Casos de Oclusión de la Carótida Interna. Presentación de Cinco Casos

Los signos angiográficos de que la carótida interna no se llena de medio de contraste no constituyen prueba terminante, por sí solos, de oclusión de dicho vaso, dado que el fenómeno puede ser consecuencia de otros factores. Hasta la exteriorización del vaso en el cuello quizás no revele la oclusión si se hace a un nivel más bajo que la oclusión. Sugiérese, por consiguiente, que, cuando se sospeche oclusión de la carótida interna a base de la angiografía de la carótida, se trate de establecer la existencia de circulación colateral: (1) desde la carótida interna o la arteria vertebral opuestas o (2) por vía de la carótida externa a través de las ramas oftálmica, meníngea media o muscular de la arteria vertebral del mismo lado. Esta última forma de circulación colateral a falta de henchimiento de la carótida interna se considera como signo angiográfico patognomónico de oclusión de la carótida interna.

En 5 casos se estableció un diagnóstico preciso de oclusión de la carótida interna por el descubrimiento angiográfico de anastomosis de las carótidas interna y externa más arriba del sitio de la oclusión, por medio de circulación retrógrada en la arteria oftálmica del mismo lado.

# Dental Bone Changes Occurring in Sickle-Cell Diseases and Abnormal Hemoglobin Traits[1]

JOSEPH R. PROWLER, Ph.B., D.D.S.,[2] and ERNEST W. SMITH, M.D.[3]

SINCE THE discovery by Pauling and his co-workers of the abnormal hemoglobin associated with sickling of the erythrocytes (1), and by others of still different hemoglobin abnormalities, it has become possible to make a precise genetic diagnosis of a variety of congenital hemolytic disorders. By use of relatively simple technics of electrophoresis of hemoglobin, the presence of sickle hemoglobin (S), hemoglobin C (2), hemoglobin D (3), hemoglobin E (4), and hemoglobin G (5) can be detected and easily differentiated from the normal. Clinical experience with patients having these abnormal hemoglobins suggests that each responsible gene acts as a simple mendelian dominant and that each is probably allelic with the determinant for normal hemoglobin. In such circumstances one would expect that an individual might inherit any combination of two of these abnormal genes and that the clinical manifestations of such inheritance would be represented by a modified expression of each. Examples of some of the possible combinations have been encountered and various observations suggest that the clinical pattern of each such genetic disorder is indeed determined by the features of the combined genes.

Those abnormal hemoglobin states which have been recognized are sickle-cell trait, hemoglobin C, D, E, and G traits, homozygous sickle inheritance (sickle-cell anemia), homozygous hemoglobin C inheritance (hemoglobin C disease) (6), homozygous hemoglobin E disease (7), and combinations of sickle and hemoglobin C, sickle and hemoglobin D, sickle and hemoglobin E, and sickle and hemoglobin G. Suggested nomenclature (8) for these disorders is given in Table I. Gene frequencies for S and C hemoglobins are relatively high in the Negro population. Hemoglobins D, E, and G, on the other hand, are apparently quite rare.

Still other hemolytic disorders may result from the inheritance of a single gene for an abnormal hemoglobin and a determinant for other red-cell abnormalities. Examples of such combinations that have been encountered are sickle-cell thalassemia (9), sickle-cell hereditary spherocytosis (10), and hemoglobin-C thalassemia (11). Despite the number of these often interrelated congenital hemolytic states, a precise genetic diagnosis can often be easily made by the use of filter paper electrophoresis of the hemoglobin and examination of the blood smear. On clinical grounds alone, even the differentiation between sickle-cell trait and sickle-cell anemia may at times be exceedingly difficult. Establishing a precise diagnosis becomes important when it is realized that the prognosis of the various genetic disorders differs greatly.

It now seems clear that sickle-cell anemia, which results from homozygosity for the sickling character, is almost invariably a severe hemolytic disorder. On the other hand, the variant forms of sicklemia are frequently mild and may have no obvious clinical expression. Many patients who were thought at one time to have mild or atypical sickle-cell anemia have been proved to have one of these variant forms (10). It seems probable

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This project was supported in part by a Research Grant of the Division of Research Grants and Fellowships, National Institutes of Health. The opinions expressed are those of the authors and in no way reflect those of the Department of the Air Force or the Department of Defense.

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TABLE I: OBSERVED COMBINATIONS OF ABNORMAL HEMOGLOBINS AND OTHER ERYTHROCYTE ABNORMALITIES

The genetic types are listed in both horizontal and vertical columns of the chart. The resultant hemoglobinopathy or hemolytic disorder appears where the columns cross.

| | NORMAL (Hgb A) | SICKLE (Hgb S) | HGB C | HGB D | HGB E | HGB G | THALAS-SEMIA | HERED. SPHERO-CYTOSIS |
|---|---|---|---|---|---|---|---|---|
| NORMAL (Hgb A) | Normal (A-A) | | | | | | | |
| SICKLE (Hgb S) | Sickle Trait (S-A) | Sickle Anemia (S-S) | | | | | | |
| HGB C | Hgb C Trait (C-A) | Sickle-Hgb C Disease (S-C) | Homozyg. Hgb C Disease (C-C) | | | | | |
| HGB D | Hgb D Trait (D-A) | Sickle-Hgb D Disease (S-D) | | | | | | |
| HGB E | Hgb E Trait (E-A) | Sickle-Hgb E Disease (S-E) | | | Homozyg. Hgb E Disease (E-E) | | | |
| HGB G | Hgb G Trait (G-A) | Sickle-Hgb G Disease (S-G) | | | | | | |
| THALAS-SEMIA | Thal. minor | Sickle-thal. Disease (S-thal.) | Hgb C-thal. Disease (C-thal.) | | Hgb E-thal. Disease (E-thal.) | | Thal major | |
| HERED. SPHERO-CYTOSIS | Hered. Spherocytosis | Sickle-Hered. Spherocytosis (S-H S.) | | | | | | Hered. Spherocytosis |

that re-evaluation of many clinical reports concerning sickle-cell anemia will reveal other such instances.

An effort has been made in our laboratory to assess the clinical manifestations in a group of patients with various sickle-cell diseases, including sickle-cell anemia (S-S), sickle-cell hemoglobin C disease (S-C), sickle-cell thalassemia disease (S-thal.), and sickle-cell hereditary spherocytosis (S-H S). The study included evaluation of the roentgenographic appearance of the skeleton. Dental roentgenograms were obtained where possible because of the observation by Robinson and Sarnat (12), in a group of 23 patients considered to have sickle-cell anemia, that the dental bones were more frequently abnormal than were the other parts of the skeleton. These authors described areas of radiolucency and a deranged trabecular pattern in the mandible or maxillae in 18 of their patients. Since all of our patients with sickle-cell anemia had both dental and general skeletal changes, it seems probable that this earlier series included some individuals with other sickle-cell diseases.

The purpose of our report is to present observations concerning the roentgenographic appearance of the dental bones of 55 persons, many of whom had some form of sicklemia. This number includes 35 individuals with various genetic forms of sicklemia, 4 with hemoglobin C trait, and 16 who had no demonstrable hemoglobin abnormality.

## METHODS

The routine methods employed in the hematology laboratories of the Johns Hopkins Hospital were employed in the clinical evaluation of our patients. In addition, a method of filter paper electrophoresis which had previously been de-

Fig. 1. Complete absence of discernible trabeculae in mandibular molar region of patient with bone change associated with sickle-cell anemia.

scribed (13) was used for detection of normal and abnormal hemoglobins. A full-mouth series of 14 dental roentgenograms was obtained from each patient. Since one technician was responsible for both exposure and processing of the film, it was possible to maintain constant roentgenographic technic in most instances. Those few patients whose films were of poor technical quality were dropped from the study unless retakes were possible. Throughout the greater part of the investigation, complete clinical oral examinations were carried out. These were discontinued when it became apparent that the only unique change was that in the radiographic appearance of the bones.

### SELECTION OF PATIENTS

*Group 1 includes 45 individuals.* Twenty-three of this group had been studied from a clinical and hematologic point of view as part of a large series with sickle-cell disease (10). In every instance the genetic form of sicklemia had been established by electrophoretic study of the hemoglobin and, where it was necessary for confirmation of the diagnosis of sickle-cell thalassemia, other members of the family had also been examined. Seven persons known to have sickle-cell trait and 2 with hemoglobin C trait were studied. Neither of the latter and only 1 of the former had experienced hematologic difficulties in the past. This was a Negro woman who had become markedly anemic during the course of a pregnancy, with a return of the hematocrit to normal following delivery. There was no clear-cut evidence of hemolytic activity, although a bone marrow aspiration performed during the third trimester of pregnancy had revealed a moderate degree of erythroid hyperplasia. Thirteen patients with varied hematologic conditions who had no demonstrable hemoglobin abnormality are also included in this group.

*Group 2 includes 10 individuals.* During the course of routine dental clinic activities, 7 persons were found to have changes in the dental bones suggestive of sicklemia. A survey of 100 sets of dental films from the files of the Dental Surgery Service revealed 3 further instances of a similar bone abnormality. The hemoglobin of these individuals was subjected to electrophoretic study: 1 was found to have sickle-cell anemia, 1 sickle-cell hemoglobin C disease, 3 sickle-cell trait, 2 hemoglobin C trait, and 2 no hemoglobin or red cell abnormality. The tenth person was a Caucasian female no longer available for study.

### RESULTS

An effort was made to grade accurately the degree of roentgenographic change of the dental bones so that our series of patients could be compared to that of Robinson and Sarnat (12). The extent to which the mandible and maxillae were involved was the basis for grading severity. *Minimal change* (+) we regarded as applicable to those dental bones which showed one or more large areas of radiolucence in the mandibular molar regions, while the remainder of the bone was within normal limits. Within the areas of radiolucency trabeculae were extremely scant, sharply defined, and without evidence of superimposition in several planes. In such areas there was generally an impression of "smearing" of the bone, as might be seen in a film exposed during patient movement. The term *moderate change* (++)

was applied to those dental bones which showed irregular areas of radiolucence in the mandibular molar regions with further areas of similar change in the bicuspid or incisor regions (Fig. 1). The maxillae in these cases were normal. *Severe change* (+++) was considered to be present in those instances in which most of the mandible was porotic and radiolucent areas were also seen in the maxillae (Fig. 2). In all cases a few trabeculae persisted about the teeth and extended to the alveolar process. In edentulous regions this band was limited to a narrow strip at the alveolar crest.

Fig. 2. Marked radiolucency of mandible and maxilla in a patient with +++ bone change associated with clinically severe sickle-cell anemia.

Data concerning the appearance of the mandible and maxilla of the 55 patients in this study are tabulated in Table II. Severe change (+++) was encountered in over one-half of the 12 patients with sickle-cell anemia, and none in this group had less than moderate (++) change. Of 12 patients with sickle-cell hemoglobin C disease, only 2 had severe (+++) change, 4 had moderate change (++), and 6 had minimal (+) change. None of this group was normal. Dental bones of the 1 patient with sickle-cell thalassemia showed moderate change. It is of interest that the 2 patients of the sickle-cell hemoglobin C group who showed severe change had experienced clinical manifestations which were relatively severe for this generally mild hemolytic disorder. Some of the individuals with S-C disease who were in the minimal change category had been totally free of clinical manifestations of their disorder.

Radiolucency of the dental bones was not restricted to individuals with sickle-cell diseases. Of the 10 members of Group 1 and Group 2 who had sickle-cell trait, 5 had apparently normal dental bones, 4 had minimal (+), and one had moderate (++) changes. This latter patient had been of prior interest because of the development of severe anemia during pregnancy, although there had been no other manifestations of sicklemia. Bone marrow aspiration from one individual with sickle-cell trait who had minimal (+) change revealed no evidence of erythroid hyperplasia. Three of the 4 individuals with hemoglobin C trait had minimal (+) change. None had any evidences of anemia, and bone marrow aspiration from 1 person who had bone changes revealed no evidence of erythroid hyperplasia.

In contrast to those persons with abnor-

TABLE II: RESULTS OF INVESTIGATION

| | Total Number of Patients | Severe Bone Change (+++) | Moderate Change (++) | Minimal Change (+) | Normal Bone |
|---|---|---|---|---|---|
| *Group I: Patients with previously established diagnosis* | | | | | |
| Sickle-cell anemia (S-S) | 11 | 6 | 5 | ... | ... |
| Sickle-cell hemoglobin C disease (S-C) | 10 | 2* | 2 | 6 | ... |
| Sickle-cell thalassemia disease (S-thal.) | 1 | ... | 1† | ... | ... |
| Sickle-cell trait (S-A) | 7 | ... | ... | 2 | 5 |
| Sickle-cell hereditary spherocytosis (S-HS) | 1 | ... | ... | ... | 1‡ |
| Hemoglobin C trait (C-A) | 2 | ... | ... | 1 | 1 |
| Apparently congenital hemolytic anemia of unknown type | 1 | 1 | ... | ... | ... |
| Lymphoma with chronic anemia, probably not hemolytic | 2 | ... | ... | ... | 2 |
| Assorted other hematologic conditions, non-hemolytic in type | 10 | ... | ... | ... | 10 |
| TOTAL | 45 | ... | ... | ... | ... |
| *Group II: Patients not previously suspected of having any hematologic disorder, but whose roentgenograms, taken solely for dental-surgical conditions, showed sickle-cell changes* | | | | | |
| Sickle-cell anemia | 1 | 1 | ... | ... | ... |
| Sickle-cell hemoglobin C disease | 1 | ... | ... | 1 | ... |
| Sickle-cell trait | 3 | ... | ... | 1 | 2 |
| Hemoglobin C trait | 2 | ... | ... | 1 | 1 |
| No hemoglobin abnormality | 3 | ... | ... | 1§ | 2 |
| TOTAL | 10 | | | | |

* Most severe disease manifestation in the sickle-cell hemoglobin C disease series.
† Mild clinical disease for severe nature of disease entity.
‡ Clinical manifestations of patient's disorder purely that of hereditary spherocytosis.
§ Caucasian female, not available for hematologic study.

Fig. 3A. Appearance of suspected bone infarct. Biopsy was performed so that upper radiolucent and lower radiopaque regions were identifiable. Compare with Figs. 3B and 3C.

mal hemoglobin trait who had bone change in the absence of erythroid hyperplasia of the marrow was 1 patient with sickle-cell hereditary spherocytosis who had normal dental bones. This patient was severely anemic and had experienced numerous hemolytic crises prior to the time at which the dental films were obtained. Another of this series had a severe hemolytic anemia which is thought to be congenital but is associated with no demonstrable hemoglobin abnormality. This patient, a young Negro female, had severe (+++) dental bone changes.

Two persons were found to have minimal (+) change of the dental bones and were subsequently examined for evidences of hematologic disorder. Neither had anemia, nor was any hemoglobin abnormality detected on electrophoretic study. One was a Caucasian, as was a third person with minimal change who is not available for clinical study.

In addition to the various degrees of radiolucence of the dental bones encountered in the study, one, two, or three discrete, rounded areas of radiodensity were found in a significant number of cases (Fig. 3A). Such areas were seen in the base bone of the mandible or the maxilla. The appearance of this peculiar region seems entirely distinct from the areas of radiodensity often seen in apposition to chronic

dental abscesses (Fig. 3B). Its sharply defined margins, the round or oval form so nearly geometric, and its lack of relation to periodontal structures serve for differentiation from cementomata and from both enostoses and condensing osteitis (Fig. 3C). At least one such area was

Fig. 3B. Appearance of regions of condensing osteitis in hematologically normal individual.

encountered in 8 of the 54 persons in this study: 2 with sickle-cell anemia, 2 with sickle-cell hemoglobin C disease, 1 with sickle-cell trait, and 2 with hemoglobin C trait. A biopsy of a dense area of bone was obtained in 5 cases. Four were reported by the pathologist as showing osteosclerosis and myelofibrosis. The remaining bone biopsy, obtained from the area shown in Fig. 3A, revealed acellular bone spicules adjoining areas of osteosclerosis and myelofibrosis. This is compatible with a diagnosis of a healing bone infarction, and the appearance of the other biopsies would suggest healed infarcts.

## DISCUSSION

In an earlier report (10) from this hospital, many of the clinical and hematologic features of sickle-cell anemia were compared to the features of various other

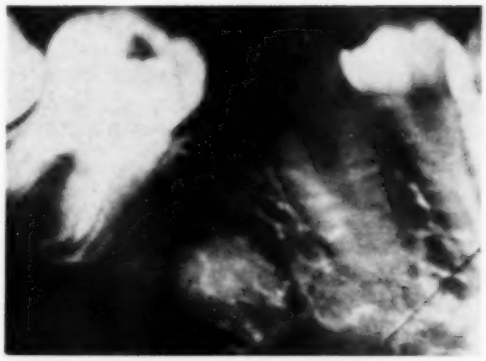

Fig. 3C. Appearance of suspected bone infarct in a patient with clinically severe sickle-cell anemia. This is the appearance of all but one of the bone infarcts observed.

sickle-cell diseases. In that study it was found that all of the patients with sickle-cell anemia who were studied had some roentgenographic changes in the general skeleton which could be attributed to sicklemia but that such changes were demonstrable in only a small number of those with other sickle-cell diseases. In the present investigation, roentgenographic changes of the dental bones were demonstrated in every instance of sickle-cell disease. Other reports of bone changes in sickle-cell anemia have included cases showing no bone abnormality. This suggests that these patients may have had genetic variants of sicklemia. A clear relationship between overall clinical severity and severity of the dental bone changes is suggested by the finding of moderately severe or severe changes in sickle-cell anemia and by the preponderance of minor changes in the clinically more mild sickle-cell variant disorders. In the sickle-cell-hemoglobin C group, pronounced dental bone changes were encountered in the 2 patients who had shown more severe and more frequent hemolytic manifestations than had the other members of the group. While not diagnostic of sickle-cell anemia, the presence of severe dental bone changes is at least suggestive of that disorder, and the finding of only minimal roentgenographic changes makes the presence of sickle-cell anemia extremely un-

likely. A mild degree of change does not indicate the occurrence of one of the other sickle-cell diseases, since similar changes were found to occur in sickle-cell trait or hemoglobin C trait and occasionally in normal individuals.

Until recently individuals with sickle-cell trait or hemoglobin C trait were considered to be clinically unaffected carriers of their respective genetic abnormalities. More recent experience with anemia of pregnancy, renal hematuria (14), and infarction of the spleen (15, 16) in patients with sickle-cell trait suggests that such is not invariably the case. Five of 10 patients with sickle-cell trait and 3 of 4 with hemoglobin C trait were found to have significant changes in the dental bones. Aspiration of bone marrow from 3 of these persons, 2 with sickle-cell trait and 1 with hemoglobin C trait, revealed no evidence of erythroid hyperplasia. These data suggest that the inheritance of a single gene for either one of these hemoglobin abnormalities may rather frequently have subclinical expression. It also seems clear that erythroid hyperplasia of the marrow is not necessary for these bone changes. The finding of similar bone changes in 2 cases with no demonstrable hemoglobin or red cell abnormality would further suggest that minimal or moderate bone changes of this nature are not specifically related to a hemolytic disorder.

The circumscribed osteosclerotic regions which are commonly seen in the long bone roentgenograms of persons considered to have a sickle-cell disease are thought to result from bone infarction. Similar areas were encountered in the mandible or maxillae of 3 patients with sickle-cell anemia, of 2 with sickle-cell hemoglobin C disease, of 1 with sickle-cell trait, and of 2 with hemoglobin C trait. The biopsy findings of osteosclerosis and myelofibrosis in four of these sites, and the additional finding of acellular bone spicules in the fifth, are compatible with healing and healed bone infarcts. This opinion is also shared by the radiologists, who feel that these areas of radiodensity in the dental bones are radiographically similar to healed bone infarcts seen in the long bones of sicklemia. In instances of sickle-cell diseases and in sickle-cell trait, such bone infarction might result from mechanical blockade of a vessel by sickled erythrocytes. However, aside from the presence of target cells in association with hemoglobin C, no morphologic change of the erythrocyte containing this abnormal hemoglobin alone or in combination with normal hemoglobin has been described. An explanation for bone infarction in association with hemoglobin C trait is not apparent.

It would seem from the results of this study that dental roentgenograms may be of considerable value in detecting individuals with hemoglobin abnormalities. Our incidence of "false positives" has been extremely low. It remains to be determined whether the occurrence of dental bone changes in some individuals who are heterozygous with respect to only one hemoglobin abnormality might indicate those in whom some other clinical manifestations of the disorder will subsequently develop. The occurrence of these bone changes in some apparently normal individuals also remains to be explained.

ACKNOWLEDGMENT: We are indebted to Dr. Majid Ajir and to Dr. Joseph Scangarella of the Dental Surgical Service of the Johns Hopkins Hospital for their assistance in collecting our data.

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SUMARIO

**Alteraciones de los Huesos Dentales Observadas en las Adrenocitemias y las Anomalías de la Hemoglobina**

Estas observaciones versan sobre el aspecto roentgenológico de los huesos dentales (maxilares superior e inferior) en 45 enfermos, comprendiendo 35 que tenían varias formas genéticas de adrenocitemia, 4 que tenían hemoglobina C y 11 sin anomalía observable de la hemoglobina. Se clasificaron las alteraciones de los huesos de acuerdo con su gravedad. Las anomalías observadas consistieron en radiolucencia de los huesos y, en un número importante de casos, en una o más zonas discretas de radiodensidad.

Observáronse alteraciones radiológicas en todos los casos de adrenocitemia. Sugiere una relación bien definida entre la gravedad clínica en conjunto y la gravedad de las alteraciones de los huesos dentarios el hallazgo de alteraciones moderadamente graves o graves en la adrenocitemia y de predominio de menores alteraciones en los varios trastornos clínicamente más leves de las células falciformes.

Aunque no es patognomónica de adrenocitemia, la presencia de graves alteraciones de los huesos dentales es a lo menos indicativa de dicho trastorno, y el hallazgo únicamente de mínimas alteraciones radiográficas convierte en sumamente improbable la existencia de drepanocitemia.

# The Radiomicrography of the Autopsy Brain

## I. The Normal Pattern[1]

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ONE OF THE AIMS of radiography is to be able to magnify the radiographic image even as histologic technics magnify the cellular composition of the gross specimen. Various methods have been employed to achieve this goal: (1) Utilization of a special tube with a small anode producing soft x-rays penetrating the specimen, which lies in close contact with a fine grain photographic plate. (2) Utilization of a point source of x-rays either by means of a pinhole serving as a secondary focus or by an extremely small focal spot roentgen tube. (3) Utilization of hard x-rays which first penetrate the photographic film, then the sample, and finally strike a heavy metal absorber such as lead. The secondary back-scatter from the lead absorber then penetrates the sample and strikes the film, producing a secondary image. (4) The electron microscope employing beta rays, alpha rays, and similar non-x-ray methods. A recent review of this subject by Bellman is summarized in Figure 1.

In most instances, these studies were made on animal tissues other than human. In the angiomicrographic technics, injections can be made in living animals just prior to death, so that ideal distribution of the contrast medium can be obtained. With human tissues, where premortem injections are impossible, the problem is more difficult, and complete perfusion of the vascular system must be obtained prior to the injection of the contrast medium in order to remove the contained blood and insure more complete filling. It is the purpose of this paper to describe such a technic for routine postmortem examination of the brain by radiomicrography.

### FACTORS INVOLVED IN RADIOMICROGRAPHY WITH SECONDARY MAGNIFICATION

1. *Size of the Focal Spot:* This must approach pin-point size.

2. *Distance Between Focal Spot and Specimen, Between Focal Spot and Film, and Between Specimen and Film:* The distance between focal spot and specimen, and between focal spot and film, must be as great as practical so as to reduce distortion to a minimum and yet not prolong exposure unnecessarily. The contact between specimen and film must likewise be maximal to avoid irregular distortion of the image.

3. *Thickness and Size of the Sample:* So long as large focus-to-object distances are used, good resolution with minimum distortion is obtained even with relatively thick samples. A sample should be thick enough so that a continuity of blood vessels is obtained to permit easier analysis. On the other hand, it must not be too thick, in order to avoid too many superimposed vascular shadows and too much backscatter. The thickness will vary with the tissue being studied and its relative vascularity and density.

4. *Spectrum of the X-Ray Beam:* The x-ray beam must be soft enough to be

[1] Accepted for publication in October 1954. Reviewed in the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are the result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

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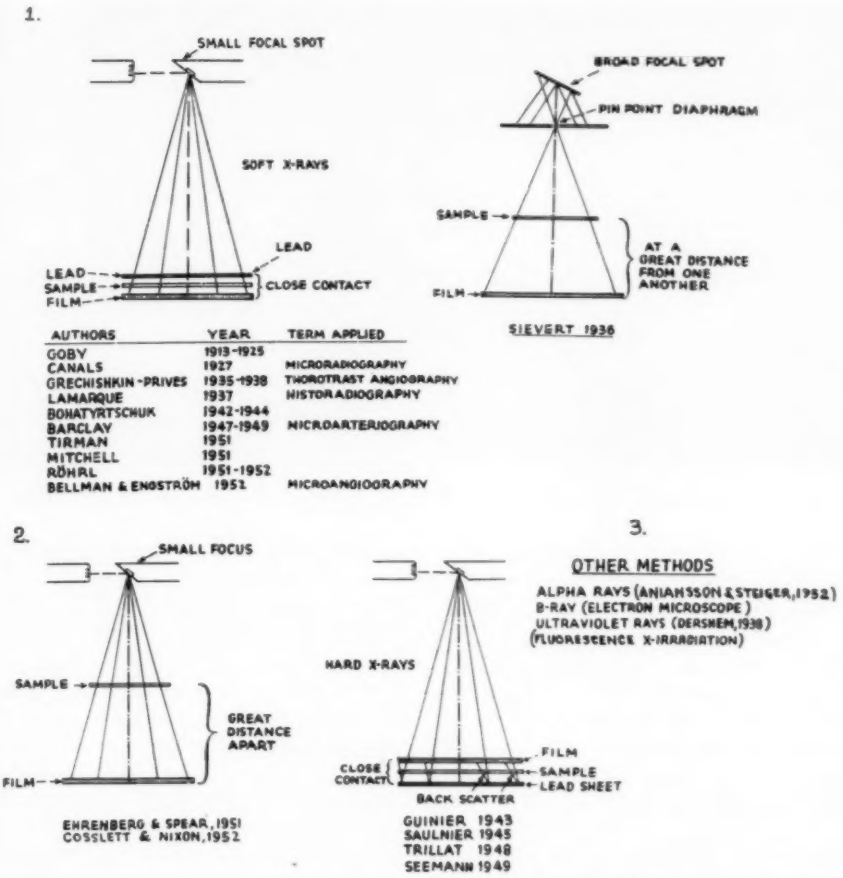


Fig. 1. Diagrammatic and tabular review of the historical background of microradiography.

partially absorbed by the medium to produce contrast, hard enough to penetrate the section, and of such character that the scattering effect is least disturbing to the image. According to Bellman, radiations harder than 1 Å should not be used when high definition in the radiomicrograms is desired. We would agree with this and find that tube, target material, and kilovoltage must be carefully selected for best results.

5. *Blurring Due to Movement:* Drying and shrinkage of samples may result in their movement in long exposures. We have overcome this difficulty by placing the specimen in a moist chamber during radiography.

6. *The Photographic Emulsion:* The most desirable characteristics of the film for radiomicrography are high resolution, good contrast, thin emulsion, and sensitivity sufficient that x-ray exposure need not be too prolonged but not too great to permit easy handling.

The emulsions which would seem to be most suitable are: Eastman Spectrographic Plates (or Film) 548-0 or 649-GH. The first permits a resolution of 500 lines per millimeter; the second approximately 1,000 lines per millimeter. Lippmann Film and Kodak Maximum Resolution Plates are similar in this respect to the 649-GH, but these have not been used in our study.

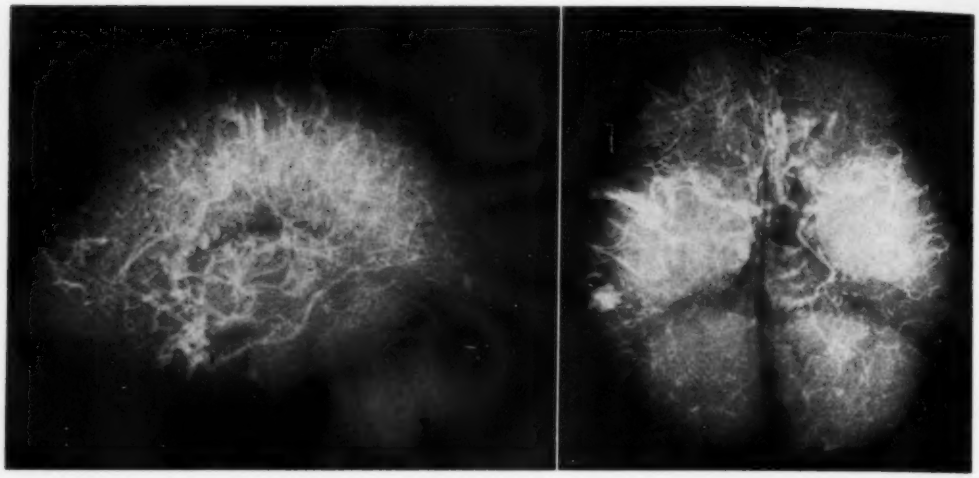

Fig. 2. Gross lateral and inferior radiographic views of injected brain before it is sectioned.

7. *Contrast Media:* Barclay used Neo-Protosil (Parke, Davis & Co.) and also Thorotrast. The Neo-Protosil is a 19 to 21 per cent silver iodide suspension with 80 per cent protein and can be used in a 20 to 50 per cent suspension mixture in water. The particle size is said to be 1 micron, but aggregation occurs readily in all but fresh solutions, and in Tirman's experience *p*H must be carefully regulated to 8.0 for best results. Our results in autopsy material with this agent have not been uniformly satisfactory, and on one occasion the material exploded after admixture with 3 per cent acacia.

Thorotrast is a colloidal suspension of 25 per cent thorium dioxide together with hydrolyzed carbohydrates in water. Its small particle size (0.1 micron) facilitates rapid diffusion through blood vessel walls. It is scarce and costly and hence not ideal for large organ infusion.

We have found that 55 per cent barium sulfate suspension in a 10 per cent gelatin-water mixture, warmed to 40° C., gives excellent results. It is abundant and cheap and its particle size[7] is ideal for visualization of capillaries without excessive diffusion into surrounding tissues.

8. *Factors Relating to Use of Autopsy Material:* In autopsy material, the blood content of the specimen must be thoroughly removed by a perfusion technic which will not cause damage or rupture of the vessels. The perfusion mixture must not be chemically irritating so that undue spasm of the arterioles is encountered. There is unfortunately no method which guarantees a complete filling of all the blood vessels of an organ, but it is probable that a pattern may be obtained for each organ which can be studied, although comments regarding quantitation of vascularity must be guarded.

## EXPERIMENTAL METHOD

*Injection of the Brain:* Both common carotids and their main subdivisions, the internal and external carotids, are isolated and cannulated before removal of the calvarium. The cannulae, in turn, are connected to a T-tube with plastic tubing. The stem of the T-tube is connected with an injection syringe containing an embalming solution (Frigid Eotex Arterial Fluid manufactured by Frigid Fluid Company, Chicago, Ill.), which is utilized for flushing of the vascular system. Each side is flushed separately until a clear solution is

[7] The suspension of barium sulfate was tested and photographed by Mr. Glen J. Dixon, electron microscopist, University of Arkansas, Fayetteville, Ark. He reported that the particle size remained unaltered in all dilutions and that the particles were homogeneous at all times.

obtained from the jugular vein on either side.

The syringe containing the Frigid Eotex is now replaced by a second syringe filled with 55 per cent barium sulfate suspended in an 8 per cent gelatin solution warmed to 40° C. First, both sides are injected simultaneously, and then each side separately, until the barium sulfate suspension is seen oozing from the jugular veins. The internal carotid arteries are thereafter tied off as close to the base of the skull as possible. The embalmer then injects the external carotid with ordinary embalming solution so as to permit proper facial preservation.

This method permits injection of the autopsied brain without hindrance to the routine embalming procedure and actually is carried out by the embalmer with little added effort.

*Removal of the Brain:* Routine removal of the brain is thereafter accomplished. The dural and arachnoidal meninges are removed from the brain and the cortex washed with warm tap water to remove the excess barium sulfate from the gyri and sulci. Stereoscopic radiographs of the injected brain are obtained at this time in the vertico-basilar and both lateral projections (Fig. 2). The brain is then suspended in formalin for ten days fixation.

*Sectioning of the Brain:* After fixation, the brain is cut into coronal sections through both cerebral hemispheres, each slice measuring 1.0 to 1.5 cm. in width (average 1.1 cm.) (Fig. 3).

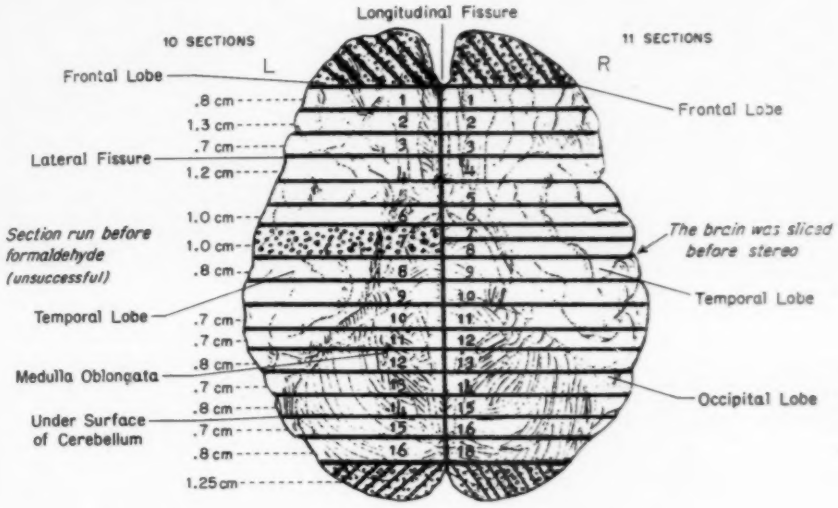


Fig. 3. Diagram showing where sections were taken from the brain.

From each section a thin slice is cut from the anterior face, measuring 5 to 8 mm. Empirically this thickness has been found to yield a fairly continuous vascular pattern, which is lacking in thinner sections. So far as possible, the entire cross section of a cerebral hemisphere is utilized. With this in view, a long film-target distance is employed and special supporting arms have been built to support the specimen-cassette combination on the North American Philips Roentgen Diffraction Unit (Fig. 4*e*). Microtome slices are necessary if thinner sections are required, but need not be used for thicker sections.

*Mounting of the Specimen for Radiography (Fig. 4):* Because of long exposure times necessary, the specimen must be placed in a "moist chamber" to prevent dehydration and shrinkage, yielding a blurred image. The moist chamber consists of a rigid rectangular wire support (Fig. 4*a*) over which is drawn a fine latex

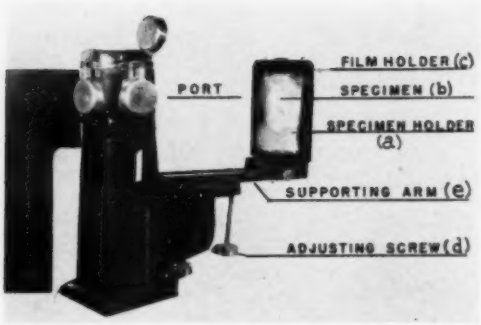


Fig. 4. Technic of mounting the brain specimen for microradiography. a. Suspension frame for "moist chamber" and specimen. b. Specimen within its moist chamber. c. Mounting of the moist chamber in close contact with the photographic plate container. d. Screw mechanism for adjustment of extension arm so that specimen is centered to the central ray of the x-ray beam. e. The mounting of the combined chamber and film on the long arm which has previously been centered to the x-ray tube by a fluoroscopic screen.

rubber casing which contains the specimen. If the rubber envelope completely encloses the specimen, no difficulty in shrinkage is encountered. A cellophane filter is interposed between this "moist chamber" and the x-ray beam in order to obtain a clearer image.

The moist chamber containing the specimen is rigidly mounted in close contact with a photographic plate holder, so that when the light-proof Bakelite plate is removed for exposure, the specimen chamber is drawn toward the plate and is brought into immediate contact with the photosensitive plate (room is darkened at this time).

The moist chamber and specimen in contact with the plate holder are placed in a supporting bracket at the end of a 76-cm. arm. Prior to placing the specimen in position, the arm is adjusted by a screw-lever mechanism (Fig. 4*d*) and a fluoroscopic screen is placed in the exact position to be occupied by the plate holder and specimen chamber. The x-ray beam is thus properly centered in relation to the specimen and photographic plate.

Once the plate holder and specimen are mounted, the room is darkened, the Bakelite cover over the photographic plate is removed, and the exposure is begun.

*The Radiographic Technic:* Eastman spectroscopic glass single emulsion plates No. 549-GH (5 × 7 inches) are employed. This permits a resolution of 500 times if required, although we have not found it necessary to utilize magnification greater than 20 times for most purposes.

A North American Philips Roentgen Diffraction Unit was employed with different test targets. Molybdenum or chromium targets gave best results, whereas, iron gave the poorest results, copper and cobalt being intermediate.

Technical factors with the molybdenum target are: 40 kv, 10 ma, 45 minutes; with the chromium target, 40 kv, 10 ma, 1 hour and 15 minutes. A cellophane filter interposed was found desirable.

The developing solution recommended by Eastman Kodak Company and found to yield most satisfactory results with the above photographic emulsion is Kodak Developer D-11. Careful temperature control during processing is very essential.

## DESCRIPTION OF VASCULAR PATTERN

A definite distinction cannot as yet be made between the arteries and veins, but it would seem that the following are the objective findings:

1. There is an arborization (the pial plexus) of small- and large-caliber blood vessels outside the surface of the cortex, which follow along the cortex into its gyri and sulci (Fig. 5A).

2. There are fine fibrillary blood vessels which are perpendicular to the outer surface of the cortex, and it would appear, at least occasionally, that these arise from the extracortical arborization. They are very uniform and closely spaced and penetrate the gray matter to the underlying white matter (Fig. 5B).

3. These penetrating vessels appear to converge on long, thin vessels of very even caliber, which traverse the full depth of each gyrus, having a pattern very much like blood vessels, following closely the neural pathways in the brain. These are arranged like sheaves of grain (Fig. 6A).

4. These vessels converge on the peri-

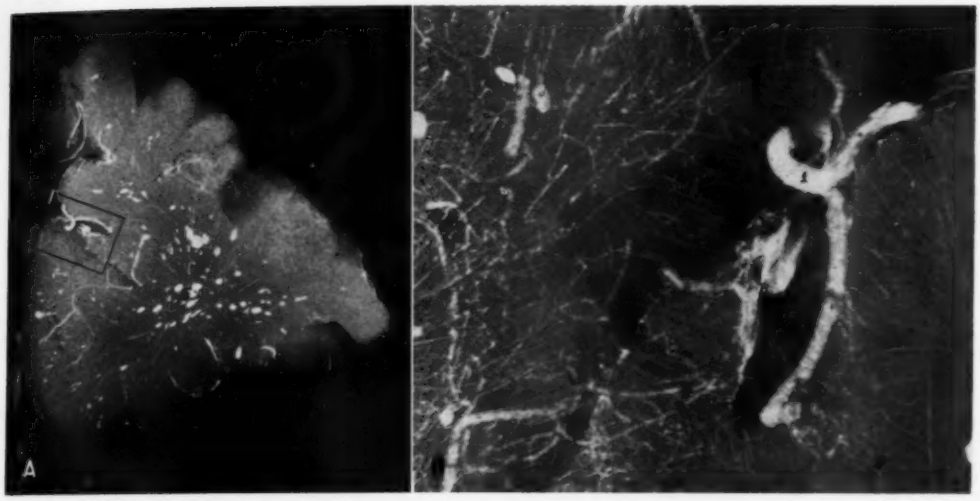


Fig. 5. A. Section through frontal lobe anterior to frontal horn. Magnification $\times c.2$. B. Section from A. Magnification $\times c.50$.

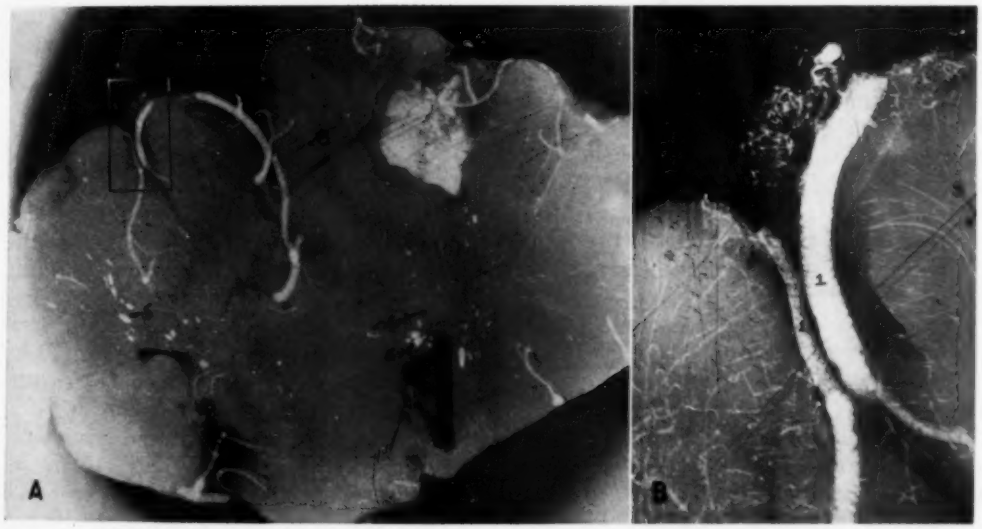


Fig. 6. A. Section through parietal lobe. Magnification $\times c.2$. B. Section from A. Magnification $\times c.50$.

ventricular white matter and arborize irregularly in the white matter several millimeters outside the ventricles (Fig. 6B). Some, however, enter the ventricles and join the choroid plexus.

5. There are clusters of blood vessels cut in cross section which traverse the brain perpendicular to the above cut surface in its white matter. These appear to be of a mixed diameter and very thin-walled.

6. Occasionally in the gray matter there are corkscrew-like vessels of very fine caliber which penetrate the gray matter and are of variable lengths (Fig. 6A).

*Interpretation of Above Findings:* Our present-day knowledge of the anatomical structures of the brain vessels is based chiefly upon the excellent studies of Pfeifer. This author has developed a very reliable method of injecting the brain vessels in

larger laboratory animals, such as cats, dogs, and monkeys. However, no such studies are available in man at the present time.

In comparing our findings with the pictures of Pfeifer, the following points can be made: (1) The arborization of small- and large-caliber blood vessels outside the surface of the cortex which follow along the cortex into its sulci belong to the vasculature of the pia mater. (2) The fine fibrillary blood vessels which emerge from those vessels perpendicularly to the surface of the cortex represent the so-called long-stem brain artery of Pfeifer. Those perpendicular vessels which are visualized throughout the cortex only seem to be identical with Pfeifer's short-stem cortical arteries. (3) An identification of arteries and veins might be possible by determining the lumen of these perpendicular vessels, for it appears that the veins usually have a larger lumen than the arteries, which are almost exclusively uniform in diameter. (4) The clusters of blood vessels which traverse the brain might be due to the thickness of our specimens, which exceeds that of Pfeifer's preparations about fifteen times. This means that part of the vessels are projected in an oblique fashion onto the film, according to the folding of the brain cortex. (5) The corkscrew-like vessels which are occasionally seen in the gray matter are difficult to interpret. They might be of pathologic significance, although they appeared in cases without other evidence of vascular disease in this study. Another explanation would be that they represent dilated capillaries. Since the injections were made by means of a syringe, the applied pressure might well have exceeded the range of physiological blood pressure.

## DISCUSSION

Before an interpretation of the above findings can be undertaken, a review of the basic anatomical concepts which can be gleaned from the literature must be undertaken. It has been extremely difficult to correlate the above findings with existing descriptions. The most inclusive accounts which we have been able to find are those of Pfeifer, Cobb, and Shenkin, Harmel and Kety. These studies have demonstrated that cerebral veins are to be found on the cortical surface, crossing over the subdural spaces and ultimately emptying into the adjacent dural venous sinuses. On the convex and medial surfaces of the brain there are twelve pairs of these veins passing to the superior sagittal sinus. Cobb has pointed out that these so-called cortical veins dip deep into the brain, well below the cortical layer, and establish free communication with the internal or deep cerebral veins.

As both Pfeifer and Cobb have pointed out, there are in addition a series of blood vessels communicating between these cortical veins and the larger blood vessels which, in turn, finally drain through the great cerebral vein of Galen and veins of that caliber into the adjoining sinuses.

It would appear reasonable, therefore, to expect that the blood vessels which we have been able to see arborizing as small- and large-caliber blood vessels situated outside the surface of the cortex, following along the cortex and dipping into the gyri and sulci, are the pial vasculature described by Pfeifer. It would seem further that there are small fibrillary branches which come directly from these veins and dip through the outer cortex into the white matter. These in turn must communicate with the vessels which are rather long and thin and radiate in the axis of the gyri and in turn join the vessels described above, finally producing the larger collecting veins which, in coronal sections of the brain, would appear to be cut transversely.

The method of angiomicrography or radiomicrography described above offers a new tool in the investigation of the finer ramifications of vascular distribution. By careful selection of colloidal particle size of the injected medium and by careful control of the pressure under which an injection is made, an effort may be made to distinguish between the arteries and

the veins. These findings can be of considerable importance in the further investigation of the dynamic anatomy of the cerebral circulation.

ACKNOWLEDGMENTS: We are indebted to Dr. George Regnier, who assisted in the initial phases of this project, to our technicians, Elmon Hall, James Thomas, Richard Chenault, and Richard Henson, and to our medical illustrators, Chris Button and Harold Bowen, whose interest permitted the progress in this investigation.

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*(Para el sumario en español, véase la página siguiente.)*

SUMARIO

**La Microrradiografía del Cerebro Autopsiado. I. El Patrón Normal**

Se describe aquí un método microangiográfico o microrradiográfico para la investigación de las más finas ramificaciones de los vasos sanguíneos de cerebro, presentándose observaciones del cerebro normal obtenido en la autopsia.

El medio usado fué una suspensión de sulfato de bario al 55 por ciento en una mezcla de agua-gelatina al 10 por ciento. Después de la fijación, se corta el cerebro en tajadas de 1.0 a 0.5 cm. de espesor, de las cuales se cortan después tajadas más delgadas para la microrradiografía. Se emplea una distancia larga de foco-película y se sostienen el ejemplar y el chasis con un accesorio especial que permite evitar la deshidratación con la consiguiente contracción.

Aunque no ha sido posible diferenciar entre arterias y venas se registran ciertos hallazgos objetivos, comparándolos con las observaciones ajenas.

# Radioactive Gold for the Intracavitary Treatment of Carcinoma of the Cervix[1]

MICHEL TER-POGOSSIAN, Ph.D., and ALFRED I. SHERMAN, M.D.

THE PURPOSE OF this paper is to describe an attempt to increase the dose of radiation delivered to the parametria for the treatment of carcinoma of the cervix. The generally accepted method of radiation therapy for carcinoma of the cervix consists in combining the radiation from a series of intrauterine and vaginal radium sources with external irradiation of the lateral pelvis. While this method delivers an adequate dose of radiation to the local lesion, the dose to the parametrial tissues is frequently insufficient to control cancer in that area. In the attempt to raise the parametrial dose of radiation to a cancerocidal level, excessive irradiation and injury to the rectum, the bladder, and the paracervical triangles may occur.

The vast amount of accumulated clinical experience places the tolerance of the rectum and the bladder in the neighborhood of 6,000 r and that of the paracervical triangles at approximately 9,000 r, when the irradiation is protracted over a period of about four weeks. The radiation tolerance of the cervix and the vaginal mucosa are considerably higher, probably of the order of 20,000 r. Consequently they do not represent a serious limitation to the amount of radium which can be placed in the vagina. Furthermore, the radiation-sensitive organs lie anterior and posterior, and above the vagina. Most conventional technics of radium therapy exploit this situation by placing the vaginal radium applicator in the lateral fornices as far as possible from the midline by distending the vagina laterally. This increases the distance between the radium sources and the rectum and bladder and brings the radium closer to the node-bearing areas. The radiation thus delivered is usually supplemented by the contribution of a series of radium sources placed in the uterine canal. Keeping within tolerance of the normal structures, such a distribution of radium applied under the best anatomical circumstances, *i.e.*, a large distensible vagina, will deliver a maximum of approximately 3,000 r to the Manchester point "B" (1, 2).

Another possible approach to the problem of protecting the bladder and rectum was investigated by Neary (3), who developed a radium applicator suitably shielded to cast a desirable protective shadow. Unfortunately, the high energy of the radiation emitted by radium requires a rather thick shield even of the heaviest metal. As a result, it is necessary to use a bulky applicator which fits only the roomiest vaginas, thus restricting the versatility of the instrument. It seemed reasonable, therefore, to explore the possibility of replacing the radium by a radioactive element emitting a lower energy radiation requiring less heavy shielding. This suggestion was mentioned by Neary and studied by Tudway (4). The object of the present report is to indicate the possibilities offered by radioactive gold ($Au^{198}$) for this purpose and to describe a practical shield which results in a desirable pattern of irradiation.

Radioactive gold 198 was selected as a source of radiation for two reasons: (*a*) It emits, per disintegration, a single gamma ray, whose energy of 411.2 kv makes it highly suitable for the proposed use. (*b*) The high cross-section of gold for neutron capture greatly facilitates the preparation of high-intensity sources required by the proposed plan of therapy. Although the practical therapeutic use of gold 198 may seem to be compromised by its short half life of 2.7 days, this limitation

[1] From the Edward Mallinckrodt Institute of Radiology and the Department of Obstetrics and Gynecology, Washington University School of Medicine, Saint Louis, Mo. Presented at the Fortieth Annual Meeting of the Radiological Society of North America, Los Angeles, Calif., Dec. 5–10, 1954.

Fig. 1. Three aspects of the vaginal lead shield.

is not a serious argument against the employment of this isotope.

We first investigated the radiation distribution from a point source of gold 198, immersed in a tissue-equivalent phantom, since radiation intensity from a source immersed in a scattering medium is dependent upon factors difficult to evaluate on theoretical considerations alone. The experiment was carried out in a water phantom approximately 30 × 20 × 40 cm. A scintillation counter probe fitted with an anthracene crystal was the radiation detector. The radiation intensity was measured in roentgen-proportional units.

The results of the experiment indicated that within a distance of approximately 6 cm. from the source in water the radiation intensity decreased as predicted by the inverse-square law. This means that the amount of radiation absorbed in the water, between the source and the detector, was compensated by the radiation scattered in the phantom. This situation is similar to that encountered with radium. The experiment was repeated with the gold source surrounded on three sides with 6 mm. of lead to simulate the conditions to be encountered in the shielded clinical applicator. No appreciable difference in results was observed. The estimated accuracy of these measurements is ±20 per cent.

It appears that the most desirable pattern of irradiation from intracavitary radioactive sources is obtained by a combination of intrauterine and intravaginal applicators. Since shielding of the

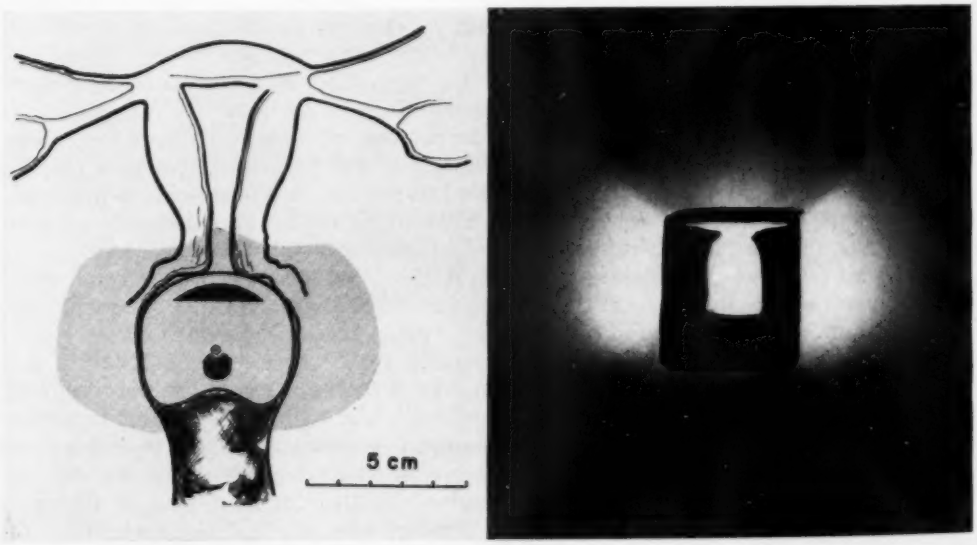


Fig. 2. Anteroposterior aspect of autoradiograph of the pattern of radiation cast by the vaginal gold applicator and schematic representation of the corresponding position of the applicator with respect to the neighboring anatomical structures. In this figure and Figs. 3 and 4 the shaded areas represent sections of the volume of tissue exposed to more than 5,000 r, while radiation-sensitive structures are kept within tolerance. In these figures only the contribution of the vaginal gold is considered. (It should be noted that the scale refers only to the drawing. No effort was made to normalize the dimensions of the autoradiograph to the drawing.)

radiation source is neither useful nor practical in the vicinity of the intrauterine sources, it was decided to use a standard uterine tandem suitably loaded with radium.

The vaginal gold source was a single pellet positioned in the mid-line and surrounded by a suitable shield (Fig. 1). The lead shield was shaped in such a fashion as to deliver the highest dose of radiation to the parametria, while the radiation-sensitive structures were kept within tolerance limits. The shape and the thickness of the lead were determined by the wide beam absorption coefficient of this metal for gamma radiation of gold as measured in this laboratory. This distribution of radiation from the applicator was obtained by exposing x-ray films in a phantom of Presdwood plates with the applicator in the center. The photographic density of the films was used to determine the isodose surfaces. The dose of radiation along a given isodose surface was obtained by measurements made with a scintillation counter probe. The results of this study for three planes at right angles are shown in Figures 2, 3, and 4. The isodose curves for the combination of the intravaginal gold and intrauterine radium are shown in Figure 5.

While the dose of radiation delivered by the intrauterine radium to the parametria is independent of the anatomy of the patient, the contribution from the intravaginal gold is strongly dependent upon the size of the vagina. With the shielded gold applicator, the limiting factor to the dose of radiation delivered to the parametria ceases to be the tolerance dose of the rectum, bladder, or paracervical triangles. These structures, being shielded, can be kept within tolerance limits. On the other hand, the radiation directed laterally must traverse the vagina and consequently the amount of radiation delivered to the parametria is limited by the tolerance of the vaginal mucosa. The depth dose of radiation sharply increases with the lateral distensibility of the vagina. For a vagina of average size, 3 cm. high and distended laterally to 5 cm., the dose delivered to various points is shown in Table I. For a smaller vagina, 4 cm. wide, the dose at "B" would be only 3,500 r, whereas for a vagina 6 cm. wide this point would be exposed to 5,850 r. It can be seen from these figures that a relatively small addition of radiation delivered by external sources is sufficient to bring the dose in the lateral pelvis to a "cancerocidal" level of 5,000 r.

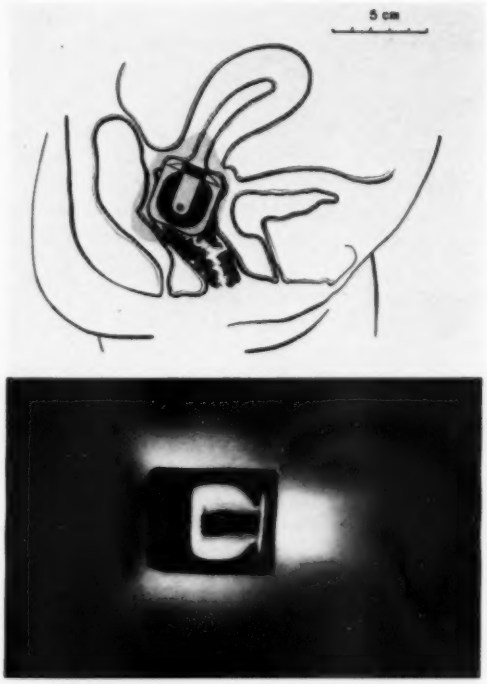


Fig. 3. Lateral aspect of autoradiograph of the pattern of radiation cast by the vaginal gold applicator and schematic representation of the corresponding position of the applicator with respect to the neighboring structures. For explanation, see Fig. 2.

TABLE I: RADIATION DOSE TO VAGINA OF AVERAGE SIZE

| | Vaginal Gold (roentgens) | Gold Plus Intrauterine Radium (roentgens) |
|---|---|---|
| Cervix | — | From 10,000 (minimum) to 22,000 (maximum) |
| Point "A" | — | 9,500 |
| Point "B" | 3,000 | 4,500 |
| Rectum | 5,000 | 6,000 |
| Bladder | 5,000 | 6,000 |
| Vaginal mucosa | 20,000 | 22,000 |

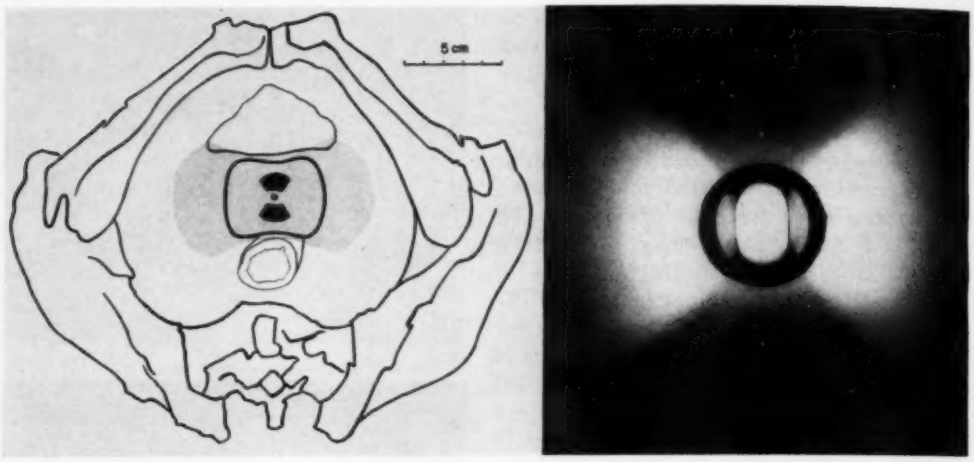


Fig. 4. Profile aspect of autoradiograph of the pattern of radiation cast by the vaginal applicator and schematic representation of the corresponding position of the applicator with respect to the surrounding structures. For explanation, see Fig. 2.

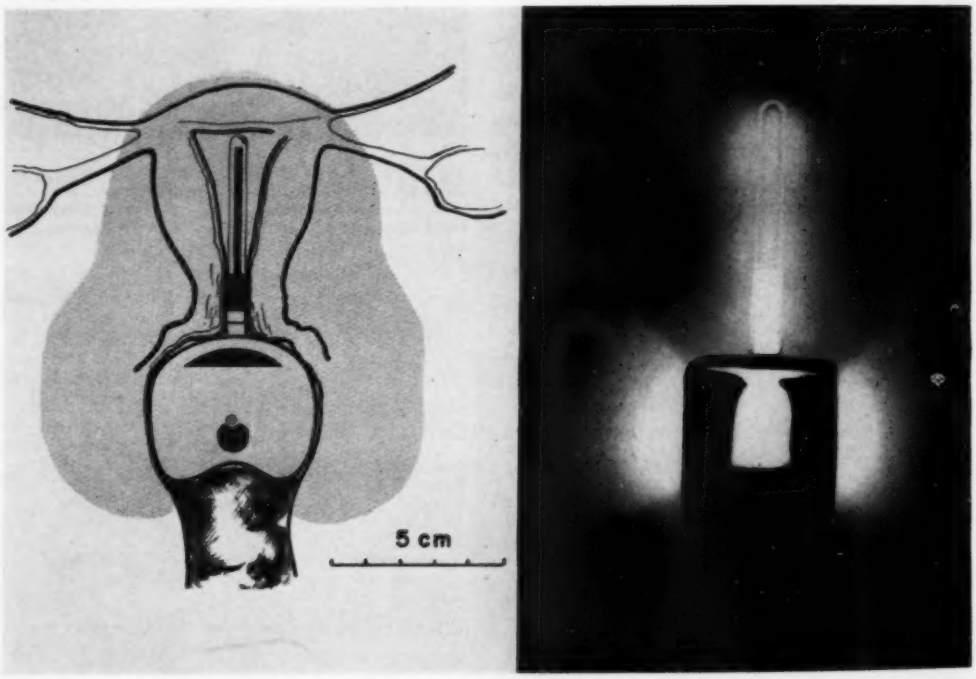


Fig. 5. Anteroposterior autoradiograph of the pattern of radiation cast by the combination of the vaginal gold applicator and a radium-loaded uterine tandem. The shaded area on the drawing represents the anteroposterior section of the volume of tissue exposed to more than 5,000 r while radiation-sensitive structures are kept within tolerance. The relative intensity of the radium sources is 4, 2, and 1. (It should be noted that the scale refers only to the drawing. No effort was made to normalize the dimensions of the autoradiograph to the drawing.)

Even in the case of a small vagina, the dose contributed by external irradiation need not exceed 1,500 r.

The activity of the gold pellet required to deliver the dose of radiation shown on Table I depends upon the time of treat-

ment, as well as the width of the vagina to be treated. Delivery to point "B" of 4,500 r in a vagina 5 cm. wide requires approximately 570 millicuries of gold destroyed (5), in addition to the uterine radium contribution. If this dose of radiation is to be delivered in thirty hours, the activity of the gold pellet must be of the order of 2 curies at the beginning of the treatment. On the basis of the current availability and price of gold 198, the use of such an applicator is found to be practical and results in a distribution of radiation superior to that obtained with radium alone. It should be noted that great caution must be observed in the use of such an instrument because a slight rotation of the vaginal portion of the applicator would bring the rectum and the bladder into a very intense field of radiation. A model of this applicator is now being designed.

## SUMMARY

In radiation therapy of carcinoma of the cervix the dose of radiation contributed by intracavitary radium is drastically limited by the tolerance of the rectum, bladder, and paracervical triangles. By surrounding the intravaginal radium with a suitable shield, it is possible to protect these radiosensitive structures and to deliver a higher dose of radiation to the parametria. Unfortunately, the high energy of the radiation emitted by radium requires a thick shield, even of the heaviest metal, which fits only the roomiest vaginas. It is proposed to circumvent this difficulty by replacing the intravaginal radium by radioactive gold 198, which emits a lower energy gamma radiation than radium and consequently requires less shielding. An intravaginal gold 198 applicator casting a desirable pattern of radiation is described.

NOTE: The authors wish to express their appreciation to Miss Lorine Mullins, R.N., for her valuable assistance in this project.

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## SUMARIO

### El Oro Radioactivo para el Tratamiento Intracavitario del Carcinoma del Cuello Uterino

En la radioterapia del carcinoma del cuello uterino, la dosis de radiación aportada por el radio intracavitario se ve inexorablemente limitada por la tolerancia del recto, de la vejiga urinaria y de los triángulos paracervicales. Circundando el radio intravaginal con un revestimiento adecuado, resulta posible proteger dichos tejidos radiosensibles y llevar una dosis mayor a los parametrios. Por desgracia, la alta energía de los rayos emitidos por el radio requiere una pantalla gruesa, hasta del metal más pesado, que no encaja más que en las vaginas más espaciosas. Propónese salvar esa dificultad empleando intravaginalmente, en vez de radio, oro radioactivo 198, que emite radiación gamma de menor energía que la del radio y por consiguiente requiere menos revestimiento. Descríbese un aplicador intravaginal de oro 198 que emite una radiación de patrón conveniente.

## Practical Image Amplifier Technics; Fluoroscopy, Cinefluorography, Spot-Film Radiography and Use with Closed Circuit Television

HERBERT M. STAUFFER, M.D., MORTON J. OPPENHEIMER, M.D., GEORGE H. STEWART III, B.S. in E.E., and ARCHIE W. BLACKSTONE, E.E.

1. *Cinefluorography:* One of the image amplifiers we have employed (Philips) is equipped commercially with an f 1.5 50-mm. lens mounted at its focal length from the output phosphor; the emergent rays are thus approximately parallel. The camera lens, focused at infinity, is brought into apposition to that of the image amplifier; this optical arrangement is not at all critical. An f 1.4 25-mm. camera lens reduces the 12- to 15-mm. phosphor image so that a complete circle is visible on each frame of 16-mm. motion-picture film. With an f 1.6 50-mm. lens the complete 16-mm. frame is covered, but a small portion of the top and bottom of the circular amplifier phosphor image is cut off. Comparable results have been obtained with a Westinghouse image amplifier made available for experimental purposes.

Fluoroscopic viewing is accomplished either directly through the amplifier lens or by a right-angle telescope. A closed circuit television pick-up can be substituted for the motion-picture camera.

We have found it entirely feasible to process relatively short runs of 16-mm. film such as are obtained in ten or fifteen seconds as, for example, in angiocardiography. We have used standard x-ray solutions right in the x-ray dark room. It has thus been possible to view by projection angiocardiographic films in clinical cases within one hour after the study is performed.

The detail of projected single frames is not nearly so good as that of a direct conventional roentgenogram but the information desired from such a study concerns dynamic processes and much can be gained from viewing the films as motion pictures. It is impossible to glean such data from one or even a series of still radiographs. In addition, a certain stereoscopic effect is simulated by the respiratory and rotatory motion of the patient, which should not be completely discouraged during cinefluorographic work since additional information is provided by the slight differences in projection which result.

To date we have used cinefluorography particularly in studies of the heart, including angiocardiography (1–4). In small animals and in infants it has been possible to use x-ray intensities below the usual fluoroscopic levels and yet obtain satisfactory motion picture film exposure at speeds up to 64 frames per second. Experimental studies have been done at speeds up to 300 frames per second and slight increases in the x-ray intensity would certainly make such ultra-slow motion analysis quite feasible.

A good film at 64 frames per second showing lung detail in a 28-cm. chest was recently obtained with a new Philips tube; the roentgen beam intensity at the patient entrance portal was 6.8 r per minute, and at the surface of the amplifier 0.084 r per minute (60 kv, 1 ma, 30 in. target to image amplifier).

2. *The Image Amplifier as a "Localizer" for Spot-Film Radiography:* It has seemed that image amplifiers might best be used in situations other than in the usually darkened standard fluoroscopic rooms as accessories of already existing fluoroscopic tables. For this reason, at the suggestion of Professor W. Edward Chamberlain, we are adapting image amplifiers to the multiplane fluoroscopic type of mounting. Such a mounting will not only permit one to do convenient cinefluorography and daylight fluoroscopy but it will also provide a cassette channel immediately in front of the face of the image amplifier so that direct spot-film radiographs can be made. A fine (0.3 mm.) focal spot x-ray tube will be used. The arrangement will permit a wide range of flexibility in positioning the patient and in positioning the x-ray beam with reference to the patient.

Encouraging preliminary results have also been obtained by employing a Polaroid-Land camera for photographing the amplifier image, with roentgenographic prints available within a few minutes after exposure.

3. *Closed Circuit Television:* A commercially available closed circuit television and monitor system with Vidicon pickup tube can readily be used in connection with the image amplifier. For the television pickup an f 1.6 50-mm. lens is employed. X-ray intensities little more than those used in conventional fluoroscopy provide a usable television image of the lung fields of adults or of other portions of the body in children and laboratory animals.

In another application, it is feasible to make measurements for stereo-encephalotomy by visualizing on the television screen the intracranial needle employed in this procedure (5).

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# EDITORIAL

## Teaching or Advertising?

Everyone agrees that scientific exhibits are of fundamental importance in medical meetings on a national scale. One should be able to obtain postgraduate education in the expanding horizons of radiology by a careful and systematic study of these exhibits at the annual meetings of the Radiological Society of North America and the American Roentgen Ray Society. Of recent years there is an increasing question in the minds of some as to whether this educational function is being fulfilled. There is a faint suspicion that competition among exhibitors is not on the basis of scientific merit, but rather in the realm of eye-appeal, scenery, and lavish display. The analogy with big industry extolling products in a competitive market is compelling. And as in business, the expense involved and the elaborate display of technical skill in presentation of medical exhibits are squeezing the little fellow out. If the scientific exhibits at our national meetings ever become the monopoly of large institutions with big budgets for advertising, the primary purpose of these exhibits will have changed, and the membership of the societies will have to reexamine the desirability of sponsorship.

It may be pertinent to reconsider what constitutes a good medical exhibit, if one agrees with the original premise that it represents an effort in postgraduate education for the benefit of those attending a medical meeting. It would seem that a scientific exhibit should be judged on the basis of three attributes: material covered, intelligibility, and attractiveness or "eye-appeal." The questions at issue are: Which of these is of most importance? What weight should be given to each?

Certainly the most important feature of an exhibit is the material which it includes. Original concepts and knowledge applicable to better care of patients should be stressed. As a corollary, it is obvious that the material should be presented in a simple, direct, concise manner, so that the observer can understand what he is looking at without the aid of an interpreter. The reader may consider this self-evident, but it is surprising that many exhibits at recent radiological meetings, especially exhibits of a technical nature, are not easily comprehended by most radiologists, unless they have become familiar with the subject beforehand. The third major attribute to be considered is the composition or attractiveness of the presentation of an exhibit. No one will deny its importance, *provided the primary requirements mentioned above have been fulfilled*. One should not be misled, however, in identifying elaborate background, and physical size (length of frame, expansiveness, or what have you) with attractiveness as it applies to medical exhibits of an educational nature. It is because of this very tendency that these comments are written; probably they will be accepted only by those who appreciate, in the words of the late Justice Brandeis, "the curse of bigness."

Perhaps the best method of combating unnecessary competition in expensive window dressing is for each member who studies the exhibits to become more critical in his evaluation of what he is looking at. In this way, public opinion among radiologists attending meetings may exert a restraining influence on our expanding radiological universe. It might be interesting to establish a ballot box at one of the annual meetings and allow the rank and file attending the exhibit to express their first, second, and third preferences. The results might prove illuminating from several points of view.

ROBERT P. BARDEN, M.D.

# ANNOUNCEMENTS AND BOOK REVIEWS

## EIGHTH INTERNATIONAL CONGRESS OF RADIOLOGY

In June, radiologists throughout the world received the Preliminary Program of the Eighth International Congress of Radiology, to be held in Mexico City July 22–28, 1956. Copies are still available and may be obtained in English, Spanish, French, or German, on request.

It is important that enrollment for the Congress be made promptly. After Jan. 1, 1956, the registration fee will be increased. Applications for hotel reservations (Form 1-A) should be sent to the Congress travel agency, Wagons Lits/Cook, Ave. Juarez No. 88, Mexico 1, D. F., as soon as possible, as accommodations will be limited and priority will be given to those who enroll early.

Members who have proffered papers to be read at the Congress will be advised after Jan. 1 whether their papers were accepted.

Communications regarding the Congress should be addressed: Eighth International Congress of Radiology, Calle del Oro No. 15, Mexico 7, D. F.

## AMERICAN BOARD OF RADIOLOGY

The deadline for filing applications for the Spring 1956 examination of the American Board of Radiology is Jan. 1, 1956. Those candidates who will complete their training by June 30, 1956, are eligible to appear at this examination.

## RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY

The following officers have been elected to head the Radiological Society of Greater Kansas City for the ensuing year, President, E. H. Stratemeier, Jr., M.D.; Secretary-Treasurer, D. R. Germann, M.D., University of Kansas Medical Center, Kansas City 3, Kansas.

## KINGS COUNTY (NEW YORK) RADIOLOGICAL SOCIETY

At a recent meeting of the Kings County Radiological Society, the following officers were elected: Louis Goldfarb, M.D., President; Hyman I. Teperson, M.D., Vice President; Ernest Melton, M.D., Treasurer; Solomon Maranov, M.D., 1450 51st, St., Brooklyn 19, Secretary.

## LOS ANGELES RADIOLOGICAL SOCIETY

The newly elected officers of the Los Angeles Radiological Society for the year 1955–56 are as follows: President, George Jacobson, M.D., Los Angeles; Vice-President, Hubert J. Prichard, M.D., Long Beach; Treasurer, Samuel C. Kahlstrom, M.D., Los Angeles; Secretary, Richard A. Kredel, M.D., 65 N. Madison Ave., Pasadena 1.

## MEMPHIS ROENTGEN SOCIETY

At a recent meeting of the Memphis (Tenn.) Roentgen Society, the following officers were elected: Dr. John E. Whiteleather, President; Dr. John M. Wilson, Vice-President; Dr. Benjamin E. Greenberg, 294 Annella St., Memphis 11, Secretary-Treasurer.

## MINNESOTA RADIOLOGICAL SOCIETY

New officers of the Minnesota Radiological Society are H. O. Peterson, M.D., St. Paul, President; A. L. Abraham, M.D., Duluth, Vice-President; O. J. Baggenstoss, M.D., 1953 Medical Arts Bldg., Minneapolis 2, Secretary-Treasurer.

## NORTH FLORIDA RADIOLOGICAL SOCIETY

At the quarterly meeting of the North Florida Radiological Society, held Oct. 6, 1955, Dr. Ivan Isaacs was elected President, and Dr. Marvin Harlan Johnston, Five Points Medical Center, Jacksonville 4, Secretary.

## SOUTHWESTERN RADIOLOGICAL SOCIETY

Radiologists of the Southwest, including Texas, New Mexico, and adjacent areas, have recently organized to form the Southwestern Radiological Society. The group meets in El Paso the second Monday of each month for dinner, followed by study or discussion of x-ray films presented by members or guests. Officers are Dr. Vincent Ravel, El Paso, Tex., President, and Dr. Gordon L. Black, 1501 Arizona Bldg., El Paso, Tex., Secretary-Treasurer.

## WEST VIRGINIA RADIOLOGICAL SOCIETY

At the annual meeting of the West Virginia Radiological Society, held Aug. 19, 1955, the following officers were elected: President, Dr. J. Dennis Kugel, Charleston; Vice-President, Dr. J. L. Patterson, Logan; Secretary-Treasurer, Dr. W. Paul Elkin, 515–519 Medical Arts Bldg., Charleston.

## POSTGRADUATE MEETING IN RADIOLOGY UNIVERSITY OF KANSAS

The annual postgraduate meeting in radiology of the radiologists of the State of Kansas and Greater Kansas City will be held at the University of Kansas School of Medicine, Kansas City, Kansas, Feb. 13–16, 1956. The list of guest speakers is as follows: Marshall Brucer, M.D., Oak Ridge, Tenn.;

Howard P. Doub, M.D., Detroit, Mich.; Benjamin Felson, M.D., Cincinnati, Ohio; John Hazard, M.D., Cleveland, Ohio; Paul C. Hodges, M.D., Chicago, Ill.; Frank Hoecker, Ph.D., Lawrence, Kans.; Howard Hunt, M.D., Omaha, Neb.; J. Martin Miller, M.D., Detroit, Mich.; Lester W. Paul, M.D., Madison, Wis.; John R. Schenken, M.D., Omaha, Neb.; Joseph D. Stickney, Cleveland, Ohio.

Information concerning this meeting may be obtained from Dr. G. M. Tice, Department of Radiology, University of Kansas Medical Center, Kansas City 3, Kans.

### BLOCKLEY RADIOLOGICAL SOCIETY

The past and present residents of the Radiological Department of the Philadelphia General Hospital recently organized the Blockley Radiological Society. The purpose of this organization is to honor Dr. Bernard Pierre Widmann, Chief of the Radiological Department for twenty-seven years, and two other radiologists of the Department with long terms of service, namely, Dr. Herman W. Ostrum and Dr. Russel F. Miller. The combined years that these three men have given the X-Ray Department at the Philadelphia General Hospital number eighty-three. During that time they have trained a total of forty-eight residents in Radiology, who now make up the membership of this organization.

Officers of the new society include the President, Dr. Philip D. Gilbert; Vice-President and Recording Secretary, Dr. Robert McLelland; Secretary and Treasurer, Dr. Samuel Finkelman. An honored guest at the first meeting was Mr. James L. Weatherwax.

### REPORTS FROM THE INTERNATIONAL CONGRESS

Two publications of interest from the Seventh International Congress of Radiology have recently appeared. The first of these, "Reports Submitted to the International Commission on Radiological Units," appeared as Supplement 117 of *Acta radiologica*. The second, containing the "Recommendations of the International Commission on Radiological Protection," was published as Supplement No. 6 of the *British Journal of Radiology* (see review on page 789 of this issue). Copies of these publications may be obtained from the respective journals. The price of the first is Sw.Kr. 25:—; of the second 10*s*. 6*d*. in paper or 12*s*. 6*d*. in cloth.

### CALEB FISKE PRIZE RHODE ISLAND MEDICAL SOCIETY

The subject for the annual essay competition for the Caleb Fiske Prize of the Rhode Island Medical Society is "Use of Radioactive Isotopes in the Treatment and Investigation of Disease."

Complete information regarding the regulations may be obtained from the Secretary, Caleb Fiske Fund, Rhode Island Medical Society, 106 Francis St., Providence 3, R. I.

### FOURTH INTERNATIONAL CONGRESS ON DISEASES OF THE CHEST

The Fourth International Congress on Diseases of the Chest, sponsored by the Council on International Affairs, American College of Chest Physicians, with the cooperation of the Federal Republic of Germany, will be held in Cologne, Aug. 19–23, 1956. The President of the Conference is Professor Gerhard Domagk, and the Honorary President is Chancellor Konrad Adenauer. Details may be obtained from the American College of Chest Physicians, 112 E. Chestnut St., Chicago 11, Ill.

## Letters to the Editor

*To the Editor of Radiology*

DEAR DR. DOUB:

While the following observations do not seem to warrant a lengthy contribution to the literature, I believe that they may be found of practical, if limited, application, in diagnostic radiology.

In the course of performing bronchograms, using the mirror technic for visualization of the vocal cords, I noted during subsequent fluoroscopy an initially unequal degree of dark adaptation of the right and left eyes. The eye behind the ENT head mirror consistently showed some degree of dark adaptation, even after passing the tracheal catheter in a normally illuminated room. Hence, it seemed likely that some degree of dark adaptation was occurring because of the head mirror. To test this possibility, the red filter of a pair of Wilson goggles was removed and replaced with opaque cardboard having a black inner surface; two holes, each about 8 mm. in diameter, were cut in the cardboard so as to overlie the pupil of each eye. No red filter or any other material covered the two holes. The air vents and other light leaks were covered with opaque tape to decrease internal reflections within the goggles. Although the type of goggle frame is not specific, it probably is important that the frame hold the cardboard sufficiently far in front of the pupil (approximately 2.5 if the Wilson goggles are used) to accomplish a collimating effect.

Tests demonstrated that almost complete adaptation was possible while wearing the goggles under normal conditions of illumination and even while looking at banks of viewing boxes or unshielded light bulbs. Adaptation was not lost if fluoroscopy was interrupted to inspect spot films through the goggles.

If the apertures in the cardboard are approximately 8 mm. in diameter, and the interpupillary distance approximately 70 mm., a roughly circular visual field 9 inches in diameter is seen at approxi-

mately 12 inches in front of the goggles. At shorter distances the field is monocular; at greater distances the field widens rapidly and becomes binocular. Using the goggles, I have found it quite easy to perform bronchograms, myelograms, T-tube cholangiograms, and other procedures best initiated with daylight and color vision, the advantage being that fluoroscopy may then be performed without waiting for an adaptation period. In addition, preliminary films and spot films of gastrointestinal series can be viewed in direct lighting without significant loss of adaptation.

Other members of the Department of Radiology of Stanford University School of Medicine have used the goggles and are in agreement with the subjective findings described above. Although the visual field is wide enough for bronchograms, myelograms, etc., the near peripheral field is greatly restricted and a few minutes practice is advised before trying to negotiate a crowded hospital corridor or turn a sharp corner; however, this is quickly learned.

Yours very truly,

WILLIAM G. FARAGHAN, M.D.
Stanford University Hospitals
San Francisco, Calif.

*To the Editor:*

A recent experience has pointed out another opportunity for error in diagnostic radiology which might well be called to the attention of others. In this instance an opaque vaginal suppository was mistaken for a bladder calculus. The offending product was a preparation in tablet form (Inserfem, manufactured by the Blue Line Chemical Co., St. Louis), each tablet containing 100 mg. diiodohydroxyquinoline, or about 64 mg. iodine. The shadow cast by this tablet varies with the projection. In our case the long axis was noted transversely, measuring 2.5 cm. The vertical dimension was 1.0 cm. and the anteroposterior dimension just under 1.0 cm. This shadow was not dissociated from the bladder in anteroposterior or lateral cystograms. It was quite dense, exhibited rather distinct laminations, and was reported as a "typical bladder stone." With increasing use of such products, this situation may arise again. Differentiation should not be difficult if the possibility of such an entity is kept in mind.

GEORGE E. IRWIN, JR., M.D.
Bloomington, Ill.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

OBSTETRICAL ROENTGENOLOGY. By ROBERT BERMAN, M.D., F.A.C.S., Assistant Clinical Professor of Obstetrics and Gynecology, New York University College of Medicine, N. Y.; Attending Obstetrician and Rotating Director of Obstetrics and Gynecology, Beth Israel Hospital, Newark, N. J.; Associate in Roentgenology, Margaret Hague Maternity Hospital, Jersey City, N. J.; Assistant Attending in Obstetrics and Gynecology, University Hospital, N. Y.; Director of Sterility Clinic, University Hospital, N.Y.; Consultant Obstetrician and Gynecologist, Irvington General Hospital, Irvington, N. J.; Diplomate, American Board of Obstetrics and Gynecology. A volume of 600 pages with numerous illustrations, including roentgenograms and diagrams. Published by the F. A. Davis Co., Philadelphia, 1955. Price $12.50.

CLINICAL ROENTGENOLOGY. VOLUME III. THE LUNGS AND THE CARDIOVASCULAR SYSTEM, EMPHASIZING DIFFERENTIAL CONSIDERATIONS. By ALFRED A. DE LORIMIER, M.D., Radiologist, Saint Francis Memorial Hospital, San Francisco, Calif.; Consultant in Radiology for the United States Army, at the Letterman Army Hospital; Consultant in Radiation Therapy for the United States Public Health Service at the U. S. Marine Hospital, San Francisco, Calif.; Formerly, Commandant, The Army School of Roentgenology; HENRY G. MOEHRING, M.D., Radiologist, Duluth Clinic, Duluth, Minn.; Formerly, Director, The Army School of Roentgenology; AND JOHN R. HANNAN, M.D., Radiologist, Cleveland, Ohio; Radiologist, Lake County Memorial Hospital, Painesville, Ohio; Formerly, Director, Medical Training, The Army School of Roentgenology; Associate Professor, Diagnostic Roentgenology, The Frank E. Bunts Educational Institute, Cleveland Clinic Foundation; Staff, Department of Roentgenology, Cleveland Clinic Foundation. A volume of 508 pages, with numerous roentgenograms. Published by Charles C Thomas, Springfield, Ill., 1955. Price $20.50.

ADVANCES IN CANCER RESEARCH. VOLUME III. Edited by JESSE P. GREENSTEIN, National Cancer Institute, National Institutes of Health, U. S. Public Health Service, Bethesda, Md., and ALEXANDER HADDOW, Chester Beatty Research Institute, Royal Cancer Hospital, London, England. A volume of 370 pages with numerous tables and graphs. Published by Academic Press Inc., New York, N. Y., 1955. Price $8.50.

J.A.M.A. CLINICAL ABSTRACTS OF DIAGNOSIS AND TREATMENT. Edited by NOAH D. FABRICANT. A volume of 628 pages, published with the approval of the Board of Trustees, American Medical Association, by Intercontinental Book Corporation, *with* Grune & Stratton, Inc., New York and London, 1955. Price $5.50.

THE MEDICAL ANNUAL. A YEAR BOOK OF TREATMENT AND PRACTITIONERS' INDEX. Editors: SIR HENRY TIDY, K.B.E., M.A., M.D. (Oxon), F.R.C.P., AND R. MILNES WALKER, M.S. (Lond.), F.R.C.S. A volume of 548 pages. Published by John Wright & Sons, Ltd., Bristol, and The Macmillan Co., of Canada, Ltd., Toronto, 1955.

EPREUVES HÉMATO-BIOLOGIQUES DANS LE LYMPHOME MALIN. By A.-P. LACHAPÈLE, Directeur de la Fondation Bergonié, and L.-J. ANDRÉ, Interne de la Fondation Bergonié. A monograph of 200 pages with numerous graphs and tables. Published by Masson et Cie, Éditeurs, 120, Boulevard Saint-Germain, Paris, VI[e] 1955.

RÖNTGENDIAGNOSTIK IM KINDESALTER. By Dr. FRANZ SCHMID, Privat-dozent für Kinderheilkunde an der Universität Heidelberg, and DR. GERHARD WEBER, Professor für pädiatrische Poliklinik an der Universität München. A volume of 546 pages, with 604 illustrations and 30 tables. Published by Lange and Springer, Berlin, 1955. Price DM 147.—

PÄDIATRISCHER RÖNTGENATLAS. Eine Sammlung typischer Bilder. By DR. M. A. LASSRICH, PROF. DR. R. PRÉVOT, AND PROF. DR. K. H. SCHÄFER, Hamburg. Edited by Dr. K. H. Schäfer. A volume of 334 pages with 700 illustrations. Published by Georg Thieme Verlag, Stuttgart, 1955. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York, N. Y. Price DM 115.— ($27.40).

## Book Reviews

THE SPINE. A RADIOLOGICAL TEXT AND ATLAS. By BERNARD S. EPSTEIN, M.D., Chief, Department of Radiology, The Long Island Jewish Hospital, New Hyde Park, N. Y. A volume of 540 pages, with 721 illustrations. Published by Lea & Febiger, Philadelphia, 1955. Price $16.50.

The author devotes the contents of this 540 page volume to a single system of the body—the spine. In his synthesis of published material from the world literature with material from his own experience of many years, he has brought forth a book of unique value to those interested in spinal problems.

The normal spine is considered first, with a discussion of the embryological aspects together with anatomical studies of the vertebrae and of the cord. Congenital malformations are discussed next, followed by endocrine and metabolic disturbances. One of the most important chapters takes up the inflammatory and degenerative diseases. Other chapters cover neoplasms, traumatic lesions, and the intervertebral disks. One chapter is devoted to diseases of the spinal cord and its coverings. Diseases of the hematopoietic, collagen, and reticuloendothelial systems are also included. An extensive bibliography is appended.

The book is clearly printed, though in the reviewer's opinion a double column form would make for easier reading. The illustrations are well chosen and generally of good quality.

Radiologists, orthopedists, and all others interested in spinal lesions will find this work of value.

RECOMMENDATIONS OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Brit. J. Radiol., Supplement 6. A volume of 92 pages, with numerous graphs and tables. Published by the British Institute of Radiology, London, 1955. Price 10*s.* 6*d.* (paper-bound), 12*s.* 6*d.* (cloth); to members of the British Institute of Radiology, 7*s.* 6*d.* and 9*s*, 6*d.*

In response to an invitation from the International Commission on Radiological Protection, the *British Journal of Radiology* has published as a Supplement the Committee's revised recommendations, covering dose rate, monitoring, department planning, protective measures, etc. This revision, as of Dec. 1, 1954, contains very few changes in the recommendations given in the National Bureau of Standards *Handbooks*, although the recommendations themselves and the basis for arriving at them are explained in a little greater detail. In some instances the wording is more exact and it is convenient to have all the material combined in one volume.

Tables and graphs are included.

LA PNEUMOSTRATIGRAPHIE. By P. BÉTOULIÈRES AND H. LATOUR, Professeurs agrégés à la Faculté de Médecine de Montpellier, with the collaboration of R. PALEIRAC and M. PÉLISSIER, Chefs de Laboratoire de Radiologie. Preface by Professeurs G. Giraud and P. Lamarque. A volume of 166 pages, with 86 figures. Published by Masson et Cie, Éditeurs, Paris, 1955.

This monograph is a rather extensive treatise on the use of gaseous contrast combined with body-section roentgenography (stratigraphy, tomography, planigraphy). The route of injection of gas and the amount used vary with the information desired. Air is the simplest gas to use, and the relatively slow rate of absorption of oxygen and nitrogen allows careful and leisurely roentgenographic examination. Precoccygeal injection may be used to demonstrate the entire retroperitoneal region and the mediastinum. The laterococcygeal, retropubic, peridural, laterovertebral, retrosternal, transtracheal, subarachnoid, cisternal, and ventricular routes may be employed under various clinical conditions for study of particular organs or areas.

Pneumostratigraphy of the mediastinum may aid in delineating the heart, great arteries and veins, pulmonary veins, and esophagus. It may be of value in demonstrating aortic aneurysm, coarcta-

tion, and persistent patent ductus arteriosus. Many conditions involving the pulmonary arteries, veins, and venae cavae are clearly demonstrated. The involvement of the trachea and primary bronchi by tumors and lymph node enlargements is also shown.

Below the diaphragm the following organs may be studied: kidneys, adrenals, spleen, stomach and esophagus, inferior vena cava, aorta, and pancreas. Here the injection of gas again results in the relative isolation of the organs while the use of body-section roentgenography aids in clarifying the desired level of study. Masses, calcification, and other pathologic manifestations in the various organs are more clearly demonstrated, as are lesions in the area of the diaphragm itself.

Pneumostratigraphy may be of advantage in studying masses in the pelvis and the neck. In selected cases, it may also prove of value in the spine, subarachnoid and ventricular spaces of the head, the orbits, and joints.

An extensive bibliography is given.

SPLÉNO-PORTOGRAPHIE. ÉTUDE RADIOLOGIQUE ET CLINIQUE DE LA CIRCULATION PORTALE NORMALE ET PATHOLOGIQUE. EXPLORATION DES ORGANES SUS-MÉSOCOLIQUES. By LUCIEN LEGER. With a Foreword by Professeur Henri Mondor. A volume of 166 pages, with 82 figures. Published by Masson et Cie, Éditeurs, Paris, 1955. Price 1,600 fr.

Splenoportography is one of the more recent developments in radiology. In this monograph, the author presents a thorough discussion of this method of roentgenographic study, describing the technic and its applications.

Valuable information concerning the portal venous circulation can be obtained before surgery by injecting contrast material such as diodone (Diodrast, iodopyracet, U.S.P.) directly into the spleen. After injection of 30 c.c. of 50 per cent solution the entire portal system may be visualized on serial roentgenograms. At one second after the beginning of injection in the normal subject, the splenic vein is visualized. In two seconds the trunk and principal branches of the portal vein are visualized and secondary hepatic branches are beginning to fill. In three seconds both intra- and extrahepatic filling of the entire spleno-portal system is seen. In from five to eight seconds most of the contrast substance is eliminated. In eleven seconds a diffuse opacification of the spleen corresponding to capillary or sinusoidal filling is seen. Portal pressure may be measured by attaching a manometer to the needle. The normal value is usually in the neighborhood of 12–14 cm. of water.

When there is obstruction to flow in the portal system, such as might be produced by splenic venous thrombosis or carcinoma of the pancreas, the filling of collateral veins results.

Obstructing lesions of the portal system include congenital stenosis, thrombosis, carcinoma of the pancreas, enlarged lymph nodes at the porta hepatis, and cirrhosis of the liver. In the Budd-Chiari syndrome, suprahepatic obstruction results in filling of the inferior vena cava. Hepatic metastases are revealed as non-filling areas. Chronic pancreatitis occasionally produces obstruction.

Numerous case histories and illustrative rotengenograms contribute to thorough presentation of an interesting method of roentgenographic study. The work should prove of value to radiologists, surgeons, and internists who are interested in this area of clinical medicine.

# ABSTRACTS OF CURRENT LITERATURE

## ROENTGEN DIAGNOSIS

### The Head and Neck


RUGGIERO, GIOVANNI, ET AL. Encephalography in Brain Tumours. A Review of 104 Cases.. 795

CASTORINA, GUIDO. Oblique Angiograms in the Diagnosis of Cerebral Tumors..... 795

HUNTER, CURWOOD R., AND MAYFIELD, FRANK H. The Oblique View in Cerebral Angiography. 795

BROWN, FLORA M., AND AYE, RALPH C. Myelographic Demonstration of the Basilar Artery 795

SCHAERER, J. P. A Case of Carotid-Basilar Anastomosis, with Multiple Associated Cerebrovascular Anomalies..... 795

MURTAGH, FREDERICK, ET AL. A Case of Persistent Carotid-Basilar Anastomosis Associated with Aneurysm of the Homolateral Middle Cerebral Artery Manifested by Oculomotor Palsy..... 795

FRANÇOIS, J., AND DE WITTE, FR. Roentgen Findings and Intracerebral Calcifications in Congenital Toxoplasmosis..... 796

POROT, J., AND LEVASSEUR, J. CL. The Osseous Lacrimal Pathway. The Possibilities of Its Radiologic Exploration..... 796

GEORGIADE, NICHOLAS, ET AL. Ossifying Fibromas (Fibrous Dysplasia) of the Facial Bones in Children and Adolescents..... 796

CHAMBERS, WILLIAM R. Headache as the First and Only Sign of Basilar Impression..... 796

ROGERS, FRED B., AND LANSBURY, JOHN. Atrophy of Auricular and Nasal Cartilages Following Administration of Chorionic Gonadotrophins in a Case of Arthritis Mutilans with the Sicca Syndrome..... 797

KOTSCHER, E. Spontaneous Subluxation of the Atlantoaxial Joint with Inflammatory Processes in the Neck..... 797

BRUWER, ANDRÉ J., AND KIERLAND, ROBERT R. Neurofibromatosis and Congenital Unilateral Pulsating and Nonpulsating Exophthalmos. 797

HOLESH, S. Diagnosis of Tumours of the Glomus Jugulare..... 798


### The Chest


GLENDINNING, A. C. Occasional Bronchography 798

MAESTRI, ALBERTO. Tomography of the Bronchi and of the Hilar Regions in Right Posterior Oblique Projection..... 798

GOUGH, J. Correlation of Radiological and Pathological Changes in Some Diseases of the Lung..... 798

RUBINSTEIN, CHARLES. Mass X-Ray Survey: City of Sydney..... 799

SIEGAL, WILLIAM, ET AL. Case Findings from Routine Chest Roentgenograms. Mass Surveys of Communities versus General Hospital Admissions..... 799

KLÍMA, JOSEF. Agenesis of the Lungs..... 799

STECKEN, A. Concerning Varices of the Lungs.. 799

ROSENMAN, EUGENE. Acute, Transient Middle Lobe Disease..... 800

FLETCHER, C. M. Classification of Roentgenograms in Pneumoconiosis..... 800

DON, CONWAY. Bronchography with Dionosil in Pulmonary Tuberculosis..... 800

ALARCON, DONATO G. Regressive Giant Bullous Emphysema in Tuberculosis of Adults..... 801

MCBURNEY, ROBERT P., ET AL. Asymptomatic Bronchogenic Carcinoma..... 801

LANGER, E., AND WILLMANN, K. H. Contribution to the So-Called Alveolar-Cell Carcinoma (Pulmonary Adenomatosis)..... 801

POHL, R. Alveolar Carcinoma of the Lung (Pulmonary Adenomatosis)..... 801

BOUCOT, KATHARINE R., ET AL. Philadelphia Pulmonary Neoplasm Research Project. Preliminary Report..... 802

MITCHELL, FRED N. Pulmonary Arteriovenous Telangiectasis..... 802

EISEN, DAVID, ET AL. A Case of Cryptococcosis with Involvement of Lungs and Spine..... 802

STRICKLAND, BASIL. Pulmonary Appearances in Polyarteritis Nodosa..... 802

YANG, SZE-PIAO, ET AL. Chest X-ray Findings and Some Clinical Aspects in Pulmonary Paragonimiasis..... 803

MOUNIER-KUHN, P., ET AL. Postoperative Bronchopathies..... 803

RÖSLI, A. J., AND SCHAUB, K. Pleurisy and Pleuritic Residua, a Quantitative Consideration..... 803

SARIN, L. R. Calcification of the Pleura..... 804

PIDONE, GRAZIANO, AND COSENTINO, GAETANO. The Use of Tomography in the Paramediastinal Pleura Following Gas Insufflation of the Mediastinum..... 804


### The Cardiovascular System


MCKAY, J. M., AND AITCHISON, J. D. The Left Lateral Oesophagram in Mitral Valvular Disease..... 804

SHORT, D. S. Radiology of the Lung in Severe Mitral Stenosis..... 804

TAYLOR, H. E., AND STRONG, G. F. Pulmonary Hemosiderosis in Mitral Stenosis..... 805

KERWIN, A. J. Ebstein's Anomaly: Report of a Case Diagnosed During Life..... 805

DUBILIER, WILLIAM, JR., ET AL. Aortic Sinus Aneurysm Associated with Coarctation of the Aorta..... 805

SHIPP, JOSEPH C., ET AL. Aortic Sinus Aneurysm. Production of Intracardiac Calcification and Pulmonary Artery Fistula..... 805

DORNEY, E. R., ET AL. Unilateral Clubbing of Fingers Due to Absence of Aortic Arch.. 806

RITTER, J. SYDNEY. Aortography ..... 806
DI GUGLIELMO, LUCIO, AND GUTTADAURO, MARIO. Radiological Visualization of the Coronary Arteries in the Living Subject. Results of 413 Observations ..... 806
MILLER, GEORGE, AND POLLOCK, BYRON E. Total Anomalous Pulmonary Venous Drainage ..... 807
BOMPIANI, CARLO. Angiocardiographic Findings in Pulmonary Tumors ..... 807
ROSATI, JARRO. Cavography and Mediastinal Pathology ..... 807
SNYDER, C. HARRISON, ET AL. Hypertension in Infancy, with Anomalous Renal Artery. Diagnosis by Renal Arteriography, Apparent Cure After Nephrectomy ..... 808
SUTTON, DAVID. Percutaneous Angiography with Special Reference to Peripheral Vessels ..... 808

**The Digestive System**

BOULLE, J. ROGER. Spontaneous Rupture of Oesophagus ..... 808
MCKIBBEN, BYRON G., AND LEE, SAMUEL. Stenosis of the Esophagus and Stomach Following the Ingestion of Corrosive Substances ..... 809
BIANCHI, GIACOMO. Examination of the Superior Portion of the Stomach by Insufflation and Stereoscopy ..... 809
LICHSTEIN, JACOB. The Differential Diagnosis of Benign Prolapse of Gastric Mucosa ..... 809
GERBER, ALEX. Gastrointestinal Distention in Infants ..... 809
MOORE, H. D. Treatment of Acutely Perforated Peptic Ulcers. Radiological Diagnosis of Site of Perforation ..... 810
LEVITT, S., AND SAINT, ERIC G. Primary Peptic Ulceration of the Jejunum ..... 810
PARIS, LEONARD. Pneumatosis Cystoides Intestinalis in Infancy ..... 810
DENENHOLZ, EDWARD J., AND FEHER, GEORGE S. Barium Reduction of Intussusception in Infancy ..... 811
KUKRAL, ALBERT J., ET AL. Abdominal Gas Cysts Complicated by Intestinal Obstruction ..... 811
JOHNSTON, M. HARLAN, AND STUBBS, GEORGE M. Sigmoidouterine Fistula Complicating Diverticulitis. Report of a Case ..... 811
SAMUEL, ERIC, ET AL. Estimation of Liver Function by Cholangiography ..... 811
COHN, EDWIN M., ET AL. The Use of Cholografin in the Postcholecystectomy Syndrome ..... 812
TWISS, J. RUSSELL, ET AL. Postcholecystectomy Oral Cholangiography ..... 812
AURELIUS, J. RICHARDS, ET AL. Retroperitoneal Cavernous Hemangioma Associated with Hemangiomas of the Skin in a Newborn. Case Report and Brief Review of the Literature ..... 812
LUDIN, H. Pancreas Visualization by Right Lateral Sagittal Tomograms After Combined Retro- and Intraperitoneal Gas Insufflation ..... 813

**The Diaphragm; Hernia**

CRASTNOPOL, PHILIP, ET AL. Surgical Correction of Eventration of Diaphragm in Patient with Arthrogryposis. Observations on Cardiac Manifestations of Traction on Diaphragm .. 813
HOLOUBEK, JOE, ET AL. Hernia Through the Esophageal Hiatus Simulating Coronary Pain. Report of Fifty Cases ..... 813
O'CONNOR, FRANCIS J., AND RITVO, MAX. Diagnosis of Hiatus Hernia on Plain Roentgenograms of the Thorax and Abdomen ..... 814

**The Musculoskeletal System**

CRAWFORD, T., ET AL. Osteosclerosis Associated with Chronic Renal Failure ..... 814
VOGL, ALFRED, ET AL. Diagnostic Significance of Pulmonary Hypertrophic Osteoarthropathy. 814
SOYKA, O., ET AL. Rare Case of the Bony Form of Hodgkin's Lymphogranuloma ..... 815
SMITH, HUGH P., AND SMITH, HUGH P., JR. Ochronosis: Report of Two Cases ..... 815
BIERLING, G., AND REISCH, D. Sudeck's Syndrome After Fractures ..... 815
CAVE, A. J. E., ET AL. Osteo-arthritis Deformans of the Luschka Joints ..... 816
KOVÁCS, ÁKOS. Subluxation and Deformation of the Cervical Apophyseal Joints: A Contribution to the Aetiology of Headache ..... 816
GOKAY, HUSAMEDDIN, AND BUCY, PAUL C. Osteochondroma of the Lumbar Spine. Case .... 816
ODELL, RICHARD T., AND KEY, J. ALBERT. Lumbar Disk Syndrome Caused by Malignant Tumors of Bone ..... 816
GINSBURG, LEONARD B., AND SKORNECK, ALAN B. Pantopaque Pulmonary Embolism. A Complication of Myelography ..... 817
MAINOLDI, FRANCO. Protrusion of the Acetabulum ..... 817
CARD, RICHARD Y., AND STRACHMAN, JEROME. Congenital Ankylosis of the Elbow ..... 817
CARROLL, ROBERT E., ET AL. Acute Calcium Deposits in the Hand ..... 817
TAKÁTS, L., AND HENYE, N. Marble Bone Disease with Brachydactylia ..... 818
HEIDENBLUT, A. Contribution to the Roentgen Diagnosis of Primary Diaphyseal Tuberculosis of the Long Tubular Bones ..... 818
JAKOB, A. Bone Changes in Trophic Disorders of the Leg ..... 818
SOTELO-ORTIZ, FEDERICO. Chronic Coccidioidal Synovitis of the Knee Joint ..... 818
TEICHERT, G. Contribution to the Analysis of Knee-Joint Roentgenograms ..... 818
HARRIS, R. I. Rigid Valgus Foot Due to Talocalcaneal Rridge ..... 819
LEITNER, BALDO. The Mechanism of Total Dislocation of the Talus ..... 819

**Gynecology and Obstetrics**

GERSHON-COHEN, JACOB, ET AL. Neglected Roentgenography of Breast Disease..... 819

BARNETT, E., AND BEWLEY, D. K. Ovarian Radiation During Hysterosalpingography... 819

EKENGREN, KRISTINA. Roentgenographic Diagnosis of Genital Tuberculosis and Roentgenographic Effects of Antibiotic Therapy.... 820

YLINEN, OLLI, AND JOHANSON, C.-E. The Role of Hysterosalpingography in the Diagnosis of Genital Tuberculosis in Women..... 820

BERGMAN, F., ET AL. Foreign Body Granulomas Following Hysterosalpingography with a Contrast Medium Containing Carboxymethyl Cellulose..... 821

**The Genitourinary System**

HINMAN, FRANK, JR., ET AL. Normal Micturition: Certain Details as Shown by Serial Cystograms..... 821

GONDOS, BELA. Foreign Body in the Left Kidney and Ureter..... 821

KUČERA, JAN, AND DVOŘÁČEK, ČESTMIR. A Contribution to the Diagnosis of Renal Adenoma 822

MORALES, OLALLO, AND ROMANUS, RAGNAR. Urethrography in the Male: The Boundaries of the Different Urethral Parts and Detail Studies of the Urethral Mucous Membrane and Its Motility..... 822

COMARR, A. ESTIN, AND BORS, ERNEST. Spermatocystography in Patients with Spinal Cord Injuries..... 822

**Technic**

LINDBLOM, KNUT. Rotation Tomography at Small Angles..... 823

**RADIOTHERAPY**

BACLESSE, F. A Method of Pre-operative Roentgentherapy by High Doses, Followed by Radical Operation for Carcinoma of the Breast (Showing Survivals up to 10 Years).. 823

SOUTHWICK, HARRY W., AND SLAUGHTER, DANLEY P. Lymphangiosarcoma in Postmastectomy Lymphedema. Five-Year Survival with Irradiation Treatment..... 823

HARDCASTLE, E. J. B. Deep X-Ray Therapy in Gynaecology..... 823

GARCIA, MANUEL. Further Observations on Tissue Dosage in Cancer of the Cervix Uteri... 824

HAHN, GEORGE A. Carcinoma of the Cervix Uteri Treated at the American Oncologic Hospital 1929–1949..... 824

MERMANN, ALAN C., AND DARGEON, HAROLD W. The Management of Certain Nonlipid Reticuloendothelioses..... 824

VOJTEK, C. The Neural Conception of the Treatment of Purulent Skin Diseases by Roentgen Irradiation..... 825

HESS, P., AND BONMANN, K.-H. Radiotherapy of Arthrosis, Spondylosis, Periarthritis Humeroscapularis and Epicondylitis..... 825

BENNER, S., ET AL. Equipment and Technique in Precision Rotation Roentgen Therapy... 825

SANTOS, CARLOS. Microlocalized Radiotherapy. 825

KISFALUDY, P., ET AL. Treatment of Malignant Tumors of the Tonsillar Region and Soft Palate..... 826

BACHMAN, C. H., ET AL. Convergent Beam Roentgen Tube..... 826

PLESCH, R., AND SCHAAL, A. Near Surface Measurements of Small Gamma Emitters by Cadmium-Sulfid Crystal-Probe..... 826

**RADIOISOTOPES**

QUIMBY, EDITH H. Radioactive Isotopes as Aids in Medical Diagnosis..... 826

ALLEN, HERBERT C., JR., AND RISSER, J. R. Simplified Apparatus for Brain Tumor Surveys..... 827

LARSSON, LARS-GUNNAR, AND JONSSON, LARS. Continuous Registration of Thyroid Uptake After Intravenous Injection of Radioactive Iodine. A Rapid Test of Iodine Concentrating Function of the Thyroid..... 827

BLUMGART, HERRMAN, L., ET AL. Treatment of Incapacitated Euthyroid Cardiac Patients with Radioactive Iodine. Summary of Results in Treatment of 1,070 Patients with Angina Pectoris or Congestive Failure..... 827

BENUA, RICHARD S., AND DOBYNS, BROWN M. Iodinated Compounds in the Serum, Disappearance of Radioactive Iodine from the Thyroid, and Clinical Response in Patients Treated with Radioactive Iodine..... 827

SLINGERLAND, D. WARD. The Influence of Various Factors on the Uptake of Iodine by the Thyroid..... 828

STANBURY, JOHN B., ET AL. The Metabolism of Iodine in 2 Goitrous Cretins Compared with that in 2 Patients Receiving Methimazole.. 828

FURTH, JACOB, ET AL. The Mechanism of Induction and the Characteristics of Pituitary Tumors Induced by Thyroidectomy..... 828

ELGEE, NEIL J., AND WILLIAMS, ROBERT H. Pituitary and Adrenal Influences on Insulin-$I^{131}$ Degradation..... 829

ELGEE, NEIL J., AND WILLIAMS, ROBERT H. Effects of Thyroid Function on Insulin-$I^{131}$ Degradation..... 829

KRISS, JOSEPH P., ET AL. Hypothyroidism and Thyroid Hyperplasia in Patients Treated with Cobalt..... 829

HULTBORN, K. A., ET AL. The Lymph Drainage from the Breast to the Axillary and Parasternal Lymph Nodes, Studied with the Aid of Colloidal $Au^{198}$..... 829

ELLIS, FRANK, AND OLIVER R. Treatment of Papilloma of Bladder with Radioactive Colloidal Gold $Au^{198}$..... 830

MCCLURE, C. C., JR., ET AL. Distribution and Pathology Resulting from the Intracerebral and Intraventricular Injection of Radioactive

Gold and Silver Coated Radiogold Colloids. 830
DAVIDSON, JACK D., AND FREEMAN, BETTY B. The Effects of Antitumor Drugs upon $P^{32}$ Incorporation into Nucleic Acids of Mouse Tumors. 830
LAJTHA, L. G., AND SUIT, H. D. Uptake of Radioactive Iron ($^{59}Fe$) by Nucleated Red Cells *in Vitro*. 830
BAXTER, C. F., ET AL. Anaemia and Erythropoiesis in the Irradiated Rat: An Experimental Study with Particular Reference to Techniques Involving Radioactive Iron. 830
RAY, ROBERT D., ET AL. Studies of Bone Metabolism. I. A Comparison of the Metabolism of Strontium$^{90}$ in Living and Dead Bone 831
MOLLISON, P. L., AND VEALL, N. The Use of the Isotope $^{51}Cr$ as a Label for Red Cells. 831

## RADIATION EFFECTS; PROTECTION

FRIEDMAN, NATHAN B. Pathogenesis of Intestinal Ulcers Following Irradiation. Effects of Colostomy and Adhesions. 831
ZUSPAN, FREDERICK P. Development of Endometrial Carcinoma Subsequent to Irradiation for Carcinoma of the Cervix. 832
BROWN, W. M. COURT, AND ABBATT, JOHN D. The Effect of a Single Dose of X-Rays on the Peripheral Blood Count of Man. 832
ELSON, L. A. A Comparison of the Effects of Radiation and Radiomimetic Chemicals on the Blood. 832
CORNATZER, W. E., ET AL. Effect of Whole-Body X-Irradiation on Lipids in the Liver, Kidney, and Spleen of Fasted Rats. 832
FORAKER, ALVAN G., ET AL. Histochemical Studies of the Effect of Irradiation of the Placenta. 832
GERSTNER, HERBERT B., ET AL. Effect of High-Intensity X-Radiation on Velocity of Nerve Conduction. 832
ALLEN, FREDERICK M. Biological Modification of Effects of Roentgen Rays. I. Reduced Temperature. 833
ZAIMAN, HERMAN, ET AL. Studies on the Nature of Immunity to *Trichinella spiralis* in Parabiotic Rats. VII. The Immune Response of the "Uninfected" Twin One Month after Its Mate Received an Immunizing Dose of Irradiated (X-Ray) Larvae. 833
TULLIS, JOHN L., ET AL. Pathology of Swine Exposed to Total Body Gamma Radiation from an Atomic Bomb Source. 833
SPELLMAN, MITCHELL W., ET AL. Effects of Somatotropic Hormone (STH) and Saline on Mice Exposed to Total-Body Irradiation. 833
NEBEL, BERNARD R. Practical Control Measures for Employees Exposed to Ionizing Radiation Hazards. 834
O'CONNELL, D. Observations on the Use of Chlorpromazine Hydrochloride in Radiation Sickness. 834
SAVITSKY, J. PHILIP. Control of Radiation Hemorrhage with Splenic Extracts. 834
SLANINA, JOSEF. The Law Relating to Work at X-Ray Installations in Hungary. 834
GABRYSH, A. F., AND DAVIS, F. J. Radon Released from Concrete in Radiant Heating. 835
BRUCER, MARSHALL. Marble as a Radiation Shield. 835

# ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Encephalography in Brain Tumours. A Review of 104 Cases.** Giovanni Ruggiero, Marcel David, and Jean Talairach. Acta radiol. **43:** 37–42, January 1955.

In the Neurosurgical Centre of St. Anne's Hospital, Paris, the fractional encephalographic technic of Liodgren (Acta radiol. **31:** 161, 1949. Abst. in Radiology **54:** 130, 1950) is used in all cases of suspected brain tumor. This procedure is no more dangerous than ventriculography. One hundred and four cases were reviewed and the diagnostic usefulness of the procedure was confirmed in 92.1 per cent.

Failure to fill the ventricles is almost always due to block and not to poor technic. If, therefore, ventricular filling is inadequate and necessary for diagnosis, ventriculography is performed.

The results in the 104 cases are presented in a table.

LAWRENCE A. DAVIS, M.D.
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**Oblique Angiograms in the Diagnosis of Cerebral Tumors.** Guido Castorina. Radiol. med. (Milan) **41:** 32–45, January 1955. (In Italian)

In addition to the standard frontal and lateral views, the author uses oblique half-axial studies in order better to separate the components of the medial and anterior cerebral groups of arteries. Such a projection allows a complete demonstration of the internal carotid, anterior cerebral, and medial cerebral arteries to their most distal branches. There is almost no superimposition of the vessels, thus allowing separate studies of the two principal arteries. In the normal oblique angiograms the courses of the anterior and middle cerebral artery are practically parallel. Any departure from this is of great diagnostic importance.

The oblique study in certain cases permits complete visualization of the circulation within the tumor, unimpeded by normal overlying vessels.

This study is particularly valuable in parasagittal and temporal tumors, in the latter of which it is possible to decide whether the tumor is cortical or deep.

Twenty-three roentgenograms, with 9 line drawings.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**The Oblique View in Cerebral Angiography.** Curwood R. Hunter and Frank H. Mayfield. J. Neurosurg. **12:** 79–80, January 1955.

The conventional anteroposterior and lateral views used in angiography will demonstrate most intracranial aneurysms. The authors present a case, however, in which these views appeared to be normal but an oblique view showed a small aneurysm arising from the middle cerebral artery. Such a view with the head rotated 45 degrees away from the side of injection, the x-ray tube overhead, and the beam projected along the base line of the skull, will usually eliminate confusing shadows and throw into relief the area most likely to harbor an aneurysm. If, because of age or a poor risk, only one view can be obtained, the oblique is to be preferred.

Three roentgenograms; 1 drawing.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

**Myelographic Demonstration of the Basilar Artery.** Flora M. Brown and Ralph C. Aye. Am. J. Roentgenol. **73:** 32–34, January 1955.

The upper vertebral and basilar arteries can be demonstrated in their position on the anterior surface of the brain stem by myelography. The technic, as described by the authors, requires first the pooling of Pantopaque in the upper cervical subarachnoid space by hyperextension of the patient's head in the usual fashion, after the lumbar injection. Following this, the head is momentarily flexed, a spot film is taken, and the head is then immediately hyperextended again. Very little of the oil escapes into the basal cisterns. This method is suggested for use in cases when arteriographic demonstration is contraindicated or is unsuccessful, and for physicians not equipped to do vertebral arteriography.

Four roentgenograms.

RICHARD G. LESTER, M.D.
University of Minnesota

**A Case of Carotid-Basilar Anastomosis, with Multiple Associated Cerebrovascular Anomalies.** J. P. Schaerer. J. Neurosurg. **12:** 62–65, January 1955.

Only 20 cases of carotid basilar anastomosis have been described in the literature. Of these, 4 were diagnosed during the patient's lifetime by angiography. A fifth case is described in this article. [For still another case, see the following abstract.]

A 40-year-old male had sudden onset of convulsions, headache, and diplopia. Examination showed a 6th nerve paralysis on the left side. Babinski's reflexes were normal bilaterally. Angiography demonstrated a berry aneurysm originating from the left middle cerebral artery about 2 cm. above the bifurcation of the internal carotid. In addition, a persistent carotid-basilar anastomosis was clearly demonstrated and the posterior cerebral and vertebral arteries were visualized by carotid injection.

The following day, the patient died. Autopsy verified the angiographic findings and revealed three other anomalies of the cerebrovascular system. (1) Both vertebral arteries were found to be very small. (2) The posterior communicating artery was absent on the left. (3) The two anterior communicating arteries were joined in the mid-line by an additional short branch.

This case bears out a point originally made by Padget, that among individuals with cerebral aneurysm the circle of Willis often shows a primitive state of development.

One angiogram; 1 photograph.

G. J. WOOLHANDLER, M.D.
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**A Case of Persistent Carotid-Basilar Anastomosis Associated with Aneurysm of the Homolateral Middle Cerebral Artery Manifested by Oculomotor Palsy.** Frederick Murtagh, Herbert M. Stauffer, and Robison D. Harley. J. Neurosurg. **12:** 46–49, January 1955.

A 62-year-old white male had diplopia and ptosis of the left eyelid, with some supraorbital pain. The only objective neurological finding was an external ophthalmoplegia on the left.

Cerebral angiography during the arterial phase demonstrated a somewhat enlarged internal carotid artery and an aneurysm in the anterior temporal

branch of the left middle cerebral artery. On the lateral views an anomalous carotid-basilar anastomosis could be demonstrated.

Operation was undertaken and the aneurysm was trapped with stainless steel clips. Eighteen months after surgery the patient's condition remained good, with no diplopia or headache.

The mechanism by which the anomalies produced the oculomotor paralysis is discussed.

Three roentgenograms.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

**Roentgen Findings and Intracerebral Calcifications in Congenital Toxoplasmosis.** J. François and Fr. De Witte. J. belge de radiol. **38:** 16–50, 1955. (In French)

This is an extensive review of the nature of toxoplasmosis, with enumeration of the symptoms and radiographic findings. In addition, 20 cases are reported. In the fetus and newborn infant the affection presents as an encephalomyelitis generally associated with a necrotic retinitis.

The evolution follows several stages. First, there is an internal hydrocephalus with external hydrocephalus or microcephaly. Neurologic disorders then develop, notably convulsive crises and muscular hypertonicity. Psychomotor and mental development are retarded. Albuminocytologic dissociation and xanthochromia are characteristic spinal fluid findings. Diffuse, continuous, bilateral electroencephalographic dysrhythmia is found. Necrosing retinitis with or without other ocular anomalies occurs in 75 per cent.

The head is large, and roentgenograms reveal enlargement of the fontanels or distention of the sutures, thickening of the internal table, accentuation of the digital impressions, and characteristic intracerebral calcifications. The calcifications, demonstrable in 87 per cent of the patients, are multiple, bilateral, superficial and deep, irregularly disseminated or grouped together. Usually they are not more than 3 or 4 mm. in diameter and are found most often in the occipitoparietal region, although they also occur in the frontotemporal region and even in the cerebellum. Form and density of the calcifications may vary, the superficial ones being nodular, while the deeper calcifications may be nodular, granular, striated, or curvilinear. With progressive necrosis or hydrocephalus, the position of the calcifications may change or they may even disappear.

In the lungs an interstitial pneumonitis may be demonstrated. Pneumoencephalographic studies usually show blockage at the foramina of Monro or the aqueduct. Serologic tests and the complement-fixation reaction aid in diagnosis.

Twenty-one roentgenograms.

CHARLES M. NICE, JR., M.D.
University of Minnesota

**The Osseous Lacrimal Pathway. The Possibilities of Its Radiologic Exploration.** J. Porot and J. Cl. Levasseur. J. de radiol. et d'électrol. **36:** 12–21, 1955. (In French)

Radiologic visualization of the nasolacrimal ducts is difficult. Even when contrast agents are injected, if a rather high obstruction is present, the condition of the osseous canal distal to the block is not demonstrated by the usual views. For the past ten years tomography has been used and has established its value.

After an anatomic study of dried skull specimens, a new position was developed which enhances the demonstration of the osseous canal with both ordinary roentgenograms and tomography. This position is called "the incidence of deflexion-rotation." The patient's head, as seen in the lateral aspect, is so placed that the line connecting the external auditory meatus and the inferior border of the orbit is 50° from the horizontal plane. The head is then rotated toward the side to be examined, so that the mid-sagittal plane is 20° from a line drawn perpendicular to the horizontal plane. After a standard roentgenogram is obtained to confirm the position, tomograms are taken.

With this technic the nasolacrimal canal is demonstrated throughout its longitudinal course from the medial and inferior margin of the orbit downward toward the region of the inferior nasal meatus, where the duct connects with the nasal cavity.

Sixteen roentgenograms; 13 drawings.

CHARLES M. NICE, JR., M.D.
University of Minnesota

**Ossifying Fibromas (Fibrous Dysplasia) of the Facial Bones in Children and Adolescents.** Nicholas Georgiade, Frank Masters, Charles Horton, and Kenneth Pickrell. J. Pediat. **46:** 36–43, January 1955.

In a ten-year period, from 1944 to 1954, 34 patients with fibrous dysplasia of the facial bones were treated at Duke Hospital (Durham, N. C.). Twenty of these patients were under eighteen years of age, with symptoms for as long as six years. The maxilla was involved in approximately 70 per cent of the group. The mandible was thought to be involved in 20 per cent, and the ethmoidal and orbital regions in the remaining 10 per cent. Seventy per cent of the patients were females.

There may be considerable deformity due to this benign growth, including proptosis and general displacement of the orbital contents. Enlargement of one side of the face with or without impairment of vision may be present. The mandibular lesions were found to occur in the region of the angle or in the anterior mandibular area.

On roentgenograms of younger patients the maxillary lesion may present a homogeneous density, with a stippled appearance. This finding will disappear in the higher age groups, as there is a tendency to greater density because of the increased ratio of bone to fibrous tissue. The margin of the tumor is generally blurred and irregular, with areas of varying density often appearing in the same lesion. In this series, patients with maxillary involvement revealed considerably greater radiopacity than those with mandibular involvement. Some of the mandibular tumors contained areas of decreased density with cyst-like characteristics.

Surgery is the treatment of choice. Complete visualization and removal of extensive ossifying fibromas of the facial bones can be accomplished by way of an extraoral approach with minimal postoperative deformity.

Four roentgenograms; 8 photographs; 1 photomicrograph.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Headache as the First and Only Sign of Basilar Impression.** William R. Chambers. J. Bone & Joint Surg. **37-A:** 189–192, January 1955.

Basilar impression is an invagination of the foramen

magnum of the skull about the upper end of the spine in such a manner that the atlas is forced upward into the rim of the foramen magnum. The odontoid process is forced against the junction of the medulla and the cervical cord, and the atlas compresses the medulla. Over a period of years irreversible damage will be done.

The use of Chamberlain's line in the roentgen diagnosis of basilar impression, or platybasia, is well known. Improved treatment of the condition requires the earliest possible diagnosis.

The suspicion of this defect should be aroused in any case of severe occipital headache. In 5 cases of basilar impression proved roentgenographically and at operation, intractable occipital headache was the first and practically the only symptom. These cases are briefly summarized.

Four roentgenograms. JOHN F. RIESSER, M.D.
Springfield, Ohio

**Atrophy of Auricular and Nasal Cartilages Following Administration of Chorionic Gonadotrophins in a Case of Arthritis Mutilans with the Sicca Syndrome.** Fred B. Rogers and John Lansbury. Am. J. M. Sc. **229:** 55–62, January 1955.

Arthritis mutilans occurs predominantly in women who have passed the menopause. It begins as a destructive process in the joint cartilage and progresses to the adjacent bone, causing bony absorption. The periarticular soft tissue shows minimal involvement; there is little fibrous ankylosis. The joints, in fact, are usually hypermobile. Bone proliferation near the joint is minimal or absent. The weight-bearing joints are relatively uninvolved. The other joints are affected sporadically or symmetrically. Generalized osteoporosis usually coexists. In spite of the severe joint destruction, symptoms are relatively minimal. There is no anemia, little muscle weakness, and minimal general fatigue. For these reasons the authors feel that it is unlikely that the disease is an atypical form of rheumatoid arthritis. It may, however, be a variant of osteoarthritis.

What is believed to be the twenty-eighth reported case of this disease is presented. The patient was a 61-year-old female with involvement of the hands and feet, the cervical, thoracic, and lumbar spine, and the sacroiliac joints. Joint pain was moderate and controlled by aspirin. Following treatment with chorionic gonadotrophins (not given by the authors), atrophy of the nasal and auricular cartilages developed and there was an exacerbation of the articular symptoms. Although an excess of gonadotrophin may occur normally at the menopause, the authors suggest that the additional amounts administered therapeutically may have precipitated the changes in the cartilages.

Three roentgenograms; 5 photographs.

D. D. ROSENFELD, M.D.
Oakland, Calif.

**Spontaneous Subluxation of the Atlantoaxial Joint with Inflammatory Processes in the Neck.** E. Kotscher. Radiol. clin. **24:** 17–24, January 1955. (In German)

Only some 50 cases of spontaneous subluxation of the atlantoaxial joint have been found in the world literature. The condition usually occurs in children under thirteen, almost exclusively with inflammatory changes in the nasopharynx or in the neck near the spinal column.

The author reports a case in an 8-year-old girl who had undergone tonsillectomy for chronic tonsillitis. On the second day after the operation, she began to hold her head tilted and to complain of pain in the side of the neck. Roentgen (standard) examination was negative. Because of persistence of the condition, the child was seen in an orthopedic clinic six months later, and tomography demonstrated a unilateral subluxation between the first and second cervical vertebrae. The anteroposterior tomograms clearly demonstrated the rotation of the atlas, the lateral masses being in different optimal cuts. This, combined with the fact that only the left apophyseal joint was seen, indicated that the right articular facet of the atlas had slid over the axis.

The clinical picture of these spontaneous subluxations is uniform: during or shortly after an inflammatory process in the neck (pharyngitis, tonsillitis, laryngitis, retropharyngeal abscess, otitis, etc.), there is a sudden onset of torticollis. If the subluxation is bilateral, no definite lateral deviation is seen. The neck is sensitive over the subluxated joints. Often a prominence can be felt in the posterior wall of the pharnyx, representing the displaced arch of the atlas. Occasionally the speech is nasal, due to a narrowing of the pharynx. While neurologic complications are unusual, marked dislocation can be fatal, as a result of compression of the medulla oblongata.

The most acceptable explanation of the condition attributes it to a slackening of the ligamentous structures, especially the transverse ligament of the atlas (which preserves the relationship of the dens of the anterior arch of the atlas), due to the hyperemia incident to the neighboring inflammatory process. These ligamentous structures in children are not as strong as in adults.

Often a porosis of the anterior arch of the atlas can be seen in an inflammatory process in this region. Subsidence of the initial inflammation results in disappearance of the porosis and torticollis.

Tomography is the most important part of the roentgen examination. Without it, the diagnosis can be missed, followed by irreparable asymmetry in the head and neck, and limitation of motion.

Five roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Neurofibromatosis and Congenital Unilateral Pulsating and Nonpulsating Exophthalmos.** André J. Bruwer and Robert R. Kierland. Arch. Ophth. **53:** 2–12, January 1955.

A small group of cases has been reported of congenital, pulsating or non-pulsating, unilateral exophthalmos associated with neurofibromatosis. The authors present 6 additional cases of congenital unilateral exophthalmos; in 5 there was dermatologic evidence of neurofibromatosis, and the sixth case may have been a *forme fruste*. In 3 of the 6 cases the exophthalmos was pulsating.

The roentgenologic appearance of these cases is typical. In the *postero-anterior view*, the orbit on the involved side generally appears larger in diameter than that of the opposite side. The inferior margin may lie much lower than normal and may show asymmetric deformity. The orbit has a "blank" appearance,

owing to the fact that none of the usual landmarks are present. Thus, the temporal line is absent and the sphenoid ridge is markedly elevated. The anterior clinoid process may be missing. The anterior ethmoid cells and the maxillary antrum on the involved side may be small. The crista galli may be displaced toward the normal side. The floor of the middle cranial fossa may be deeper than that on the opposite side. The *lateral view* may disclose absence of a variable portion of the orbital plate of the frontal bone. The lesser wing of the sphenoid, the anterior clinoid process, and even the posterior clinoid process may be absent or deformed. The sella is deformed and is scooped out on the involved side. The floor of the middle cranial fossa may be deepened, and the fossa usually extends farther forward than normally. In the *optic canal view* some cases of neurofibromatosis of the orbit have shown a striking enlargement of the optic canal, "suggesting involvement of the optic nerve or its sheath with neurofibroma." A *view of the base of the skull* is excellent for demonstration of anterior displacement of the middle fossa on the affected side.

The mechanism of the exophthalmic pulsation is discussed.

Fourteen roentgenograms; 6 photographs; 2 drawings.

**Diagnosis of Tumours of the Glomus Jugulare.** S. Holesh. Lancet **1**: 169–170, Jan. 22, 1955.

Tumors of the glomus jugulare, once thought to be rare, are now being recorded with increasing frequency. This tumor should be considered in a patient giving a long history of increasing unilateral deafness, a hemorrhagic otorrhea, or a vascular polyp in the ear. As the tumor spreads, neurological disturbances occur, multiple cranial palsies being characteristic. The cranial nerves most frequently involved are the seventh, eighth, ninth, tenth, eleventh, and twelfth. Although few patients present with neurological symptoms, 40 per cent of the reported cases had clinical evidence of some neurological disturbance, such as hoarseness due to involvement of the vagus.

The radiologic features of a tumor of the glomus jugulare are as follows:

(1) Sclerosis of the mastoid, which cannot be differentiated from a chronically infected mastoid without tomography.

(2) Destruction of the lower portion of the petrous pyramid, the ridge remaining as a more or less intact shell. The type of erosion peculiar to glomus tumors can be demonstrated satisfactorily only by tomography, a very simple procedure in this area.

(3) Enlargement of the jugular foramen on the affected side, with perhaps a mass in the posterior nasopharynx.

(4) On arteriography, a tortuous mass of new vessels in the neck, the petrotemporal region, or posterior fossa. Alexander *et al.* (J. Neurosurg. **8**: 515, 1951. Abst. in Radiology **59**: 271, 1952) think that the early blood supply of the tumor is from the external carotid artery and later also from the vertebral artery. They state that the tumors are best seen in the venous phase of the arteriogram.

(5) Signs of raised intracranial pressure, such as thinning and destruction of the clinoids, when the tumor has extended widely into the middle and posterior fossa.

Destruction of the base of the skull, including the petrous bone, may be seen in acoustic neuroma, primary tumors of the nasopharynx, chordoma, carcinoma of the sphenoidal sinus, and metastatic carcinoma, but the erosion in glomus tumors differs in its site of origin and other features. The vascularity of the glomus tumor as seen on angiograms is never a feature of these lesions and this, coupled with the tomographic findings, clinches the diagnosis.

Five cases are reported. Two were proved histologically and 1 had all the characteristic clinical and radiological findings. The other 2 cases are probably glomus tumors in view of the long clinical history, relatively benign course, multiple cranial palsies, and characteristic tomographic appearance.

Three roentgenograms.

## THE CHEST

**Occasional Bronchography.** A. C. Glendinning. Lancet **2**: 1253–1255, Dec. 18, 1955.

The author believes that bronchial intubation is more suitable than cricothyroid puncture for the radiologist who performs bronchography only occasionally. He describes his own technic in detail, not as offering anything new or controversial but simply as a step-by-step guide to the inexperienced.

**Tomography of the Bronchi and of the Hilar Regions in Right Posterior Oblique Projection.** Alberto Maestri. Ann. di radiol. diag. **27**: 87–107, 1954. (In Italian)

The author describes in detail the application of tomography to the study of the large bronchi and of the hilar regions, with special emphasis on the positioning of the patient to place the bronchial axis in the plane of the tomograph.

Tomography of the bronchi has not been widely employed in America, probably because of the ease and certainty with which the same information is often obtained by means of bronchography. It is true, however, that sometimes tomography will disclose the needed information without the discomfort of bronchographic examination. Tomography will also visualize thickening of the bronchial walls which does not affect the lumen of the bronchi.

Nineteen roentgenograms.

CESARE GIANTURCO, M.D.
Urbana, Ill.

**Correlation of Radiological and Pathological Changes in Some Diseases of the Lung.** J. Gough. Lancet **1**: 161–162, Jan. 22, 1955.

In an earlier paper (Gough, James, and Wentworth: J. Fac. Radiologists **1**: 28, 1949. Abst. in Radiology **54**: 902, 1950), a rather unusual technic for preparing and cutting sections of the entire lung in the sagittal plane was described. These sections are mounted on paper so they can be viewed with transmitted light. Certain glycol derivatives are used to preserve the natural colors, and staining is thus unnecessary. While they have been employed primarily in pneumoconiosis, the author has found these sections valuable in correlating the radiologic and pathologic changes in other conditions of the lungs.

In some cases of mitral stenosis the lung fields show linear markings particularly in the lower parts, where a series of parallel lines run in from the chest wall above the costophrenic angles. Sometimes these are very

sharply outlined and about a millimeter in thickness. A study of paper-mounted sections suggests that in some cases these lines are due to the deposition of hemosiderin in the septa between the secondary nodules and in others to edema of the interlobular septa.

The need for careful correlation of radiological and pathological findings is illustrated by a case of microlithiasis alveolaris pulmonum. During life the patient was thought to have gross chronic hemosiderosis of the lungs with mitral stenosis. At autopsy microlithiasis alveolaris pulmonum was found. When sections of the lung were mounted on paper they felt exactly like sandpaper; the material, however, had not been inhaled but was endogenous and composed of calcium phosphate and calcium carbonate.

The author has compared the lungs of people dying from the emphysema associated with chronic bronchitis with those dying in status asthmaticus. Radiologically chronic bronchitis and asthma do not show two distinct types of radiolucency, but anatomically the changes are quite different. In a series of 17 cases of fatal status asthmaticus, bullous emphysema was present in only 1, and in this instance there was associated severe bronchiectasis. In the other cases the lungs were simply overdistended as in drowning. The importance of this seems to be that the inflation of the lung in asthma is reversible, whereas the destructive processes in chronic bronchitis are permanent. It is important to learn more about these conditions, and there is need of a radiological technic to help in distinguishing the various forms of emphysema and to show at what stage destructive processes take place.

Herrnheiser and Hinson (Thorax **9**: 198, 1954) investigated the distribution of the edema which occurs in uremia by means of paper-mounted sections. They have described its anatomical distribution and relate it to the concept of lung anatomy according to which each lobe is divisible into a lobar root, a medulla, and a cortex. In uremia, the edema is limited to the medullary part.

Paper-mounted sections have not been used for the investigation of tuberculosis apart from that of coal workers. The technic is satisfactory only when a lobe or a whole lung can be studied. The sections show how much diseased and how much healthy tissue has been removed and whether bronchiectasis is associated with the tuberculosis. Thus they may help in deciding why some patients do well and others do not.

**Mass X-Ray Survey: City of Sydney.** Charles Rubinstein. M. J. Australia **1**: 31–34, Jan. 8, 1955.

A chest x-ray survey, compulsory for all residents over the age of fourteen, was carried out in the city of Sydney (estimated population 210,000) in 1953. Four mobile units were used, and an average of 1,900 roentgenograms were taken per day. A total of 192,297 persons were examined. For approximately 50 per cent, it was their first x-ray examination.

Three hundred and twenty-nine persons with new active lesions and 23 with a history of previous tuberculosis were found. Bacteriologic proof was obtained in all but one. In addition, 1,886 cases of inactive tuberculosis and 901 of non-tuberculous disease were detected. Of the 329 new and active cases, 240 were in males and 89 in females. The majority of the females were under the age of forty (58 cases) and the majority of males were over forty (180 cases). Approximately 20 per cent of the persons examined were born outside Australia. The highest incidence of tuberculosis was found among males of Chinese origin (1.1 per cent), and the second highest among persons from the United Kingdom.

Nine tables.

**Case Findings from Routine Chest Roentgenograms. Mass Surveys of Communities versus General Hospital Admissions.** William Siegal, Robert E. Plunkett, and Ben Z. Locke. J.A.M.A. **157**: 435–440, Jan. 29, 1955.

During a period of about six and one-half years, 1,076,506 patients in 71 general hospitals in New York State (not including New York City) had chest roentgenographic examinations on admission, and 1,069,715 persons were examined in special group and community surveys. On initial interpretation of the films, almost twice as much definite and suspected tuberculosis was found in the hospital surveys as in mass surveys. In both programs the rates for all categories of tuberculosis, *i.e.*, probably active, probably inactive, and suspected, increase with age for both sexes, but the rates for males are almost always greater than for females. Eighty-three per cent of the initially diagnosed hospital cases and 86 per cent of the mass survey cases had never been reported previously. In both programs, possible tumors are diagnosed two and one-half times more frequently in males than in females. Sufficient data are not yet available for definitive findings of pulmonary tumor cases.

One graph; 6 tables. SHOZO IBA, M.D.
Huntington Park, Calif.

**Agenesis of the Lungs.** Josef Klíma. Acta radiol. & cancerol. bohemoslov. **8**: 177–180, July 1954. (In Czechoslovakian)

Roentgenograms and case histories are presented of 2 patients with congenital agenesis of one lung. The more or less incidental discovery of the abnormality in these patients—a 31-year-old man and a 66-year-old man who performed their daily work without difficulty—shows the limited clinical importance of the absence of one lung. The younger patient had been treated for many years for "pleurisy"; in the second patient the abnormality was found on the occasion of an x-ray examination following an injury.

Three roentgenograms. E. A. SCHMIDT, M.D.
Hilo, Hawaii

**Concerning Varices of the Lungs.** A. Stecken. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 54–63, January 1955. (In German)

Varicosities of the pulmonary veins are extremely rare; only 7 cases could be found in the literature. The changes are as a rule not harmful as they are mostly asymptomatic and rarely give rise to a hemoptysis. On the other hand, knowledge of their existence is important, as they are easily confused with arteriovenous aneurysms, tuberculosis, and neoplasms. They may be associated with varices elsewhere in the body.

Roentgenologically, the author describes a broad band form, a spindle-shaped form, and sharply demarcated oval densities. Tomography is useful for determining the exact location of the lesions and their connection with the pulmonary veins. Angiography is not indicated because of the innocuous nature of the condition.

Two cases are described. In the first, an erroneous

diagnosis of tuberculosis had been entertained elsewhere for a period of thirteen years. In the second case no definite diagnosis had been attempted, but tuberculosis and various types of neoplasm had been suspected for ten years. Tomography was helpful in establishing the diagnosis in each instance.

Seven roentgenograms. ERNEST KRAFT, M.D.
Newington, Conn.

**Acute, Transient Middle Lobe Disease.** Eugene Rosenman. Dis. of Chest **27**: 80–87, January 1955.

It is suggested that the term "middle-lobe disease" be used for all cases of middle-lobe atelectasis and pneumonitis which are not caused by active tuberculosis or neoplasm, and that "middle-lobe syndrome" be used as an all-inclusive term for middle-lobe atelectasis, regardless of etiology. Atelectasis confined to the middle lobe is more common in adults because of the acute angle at which the middle-lobe bronchus arises and because of its position in the lymphatic pathway draining both the middle and lower lobes of the right lung.

Acute transient middle lobe disease is described in 4 patients, due probably to inadequate drainage and mucous plug formation. The disease may frequently be overlooked on the postero-anterior roentgenogram and its diagnosis must be made from a lateral view or fluoroscopy in the lordotic position.

Nine roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Classification of Roentgenograms in Pneumoconiosis.** C. M. Fletcher. Arch. Indust. Health **11**: 17–28, January 1955.

Herein is proposed a system for classification of roentgenograms in coal pneumoconiosis and the various forms of silicosis.

In this system a separation is made into simple pneumoconiosis and complicated pneumoconiosis. Simple pneumoconiosis, which refers to films showing discrete opacities, is further subdivided into 3 categories based upon the extent of diffusion throughout the lung fields. Thus, in Category 1, a few opacities are present in the second, third, or fourth anterior rib spaces, midway between the mediastinum and the periphery. In Category 2, the opacities are more numerous throughout the lung fields, but are usually less profuse in the peripheral third. In Category 3, the opacities are distributed throughout all of both lung fields, but they may be relatively sparse in the apices.

Complicated pneumoconiosis films show coalescent or massive shadows on a background of larger, less well defined opacities. These are usually distributed over the upper and midlung fields, between hilus and periphery, with a tendency to grow and to coalesce. With the development of progressive massive fibrosis, the shadows tend to contract, with subsequent development of gross emphysema and distortion of lung architecture. Four categories are recognized. Category A includes shadows occupying at least one anterior rib space. In Category B, the shadows extend over less than three anterior rib spaces, and in Category C over more than three anterior rib spaces. In Category D, the shadows are associated with serious distortion of pulmonary architecture.

A serious source of error in classifying pneumoconiosis films rests with the interpreter. This can be reduced by the use of standard reference films and by duplicate reading of all films.

Seven roentgenograms; 4 charts; 1 graph; 2 tables.
DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Bronchography with Dionosil in Pulmonary Tuberculosis.** Conway Don. J. Fac. Radiologists **6**: 189–200, January 1955.

The author has used Dionosil, a new water-suspended contrast medium, for bronchography in 90 cases of pulmonary tuberculosis. Eighty-five of the patients had acute or spreading disease, but bronchography was performed only when the process had become stabilized; 82 had positive sputum and/or cavitation. Sixty-three patients were about to undergo surgery, and in 9 others it was being considered. In the majority of the remaining 18 cases, bronchiectasis was suspected and bronchography was performed either to determine the presence and degree of that condition or to show more precisely than plain radiography the structural changes in the lung. There was only one instance of spread of tuberculosis after bronchography. While this was quite probably not due to the procedure, subsequently it was felt safer to use streptomycin "cover" if any question existed as to the stability of the disease.

Satisfactory bronchograms were obtained in 87 cases, and bronchiectasis was demonstrated in 68 (78 per cent). In the preoperative cases it was present in 56 out of 71 (79 per cent), being moderate or severe in 44 per cent.

The most obvious value of preoperative bronchography would appear to lie in the demonstration of the degree and localization of bronchiectasis; the degree, in particular, was found difficult to gauge with any success from plain roentgenograms. Bronchography is also the most accurate preoperative method of localizing cavities and other pulmonary lesions to the correct lobe or segment. It demonstrates the preoperative bronchial anatomy (of particular advantage before segmental resection). It gives a more exact idea of the volumes occupied by the various lobes (of service in assessing the volumetric changes to be expected after lobar or segmental pulmonary resection). From time to time it shows gross bronchial disease in regions where it had not been suggested by plain radiography or tomography; in 2 of the cases in the present series it revealed unsuspected bronchostenosis.

There is one difficulty in the interpretation of the bronchogram—namely, that it will not distinguish bronchiectasis due to adult tuberculosis from that attributable to previous primary tuberculous infection.

Views on the significance of bronchiectasis in the treatment of pulmonary tuberculosis vary widely, and a great deal of work remains to be done on the subject. The greatest need is probably for controlled series of cases, to assess the relative success of collapse therapy (and particularly of thoracoplasty) in those patients with no bronchiectasis, those with little bronchiectasis, and those with severe bronchiectasis. It is quite obvious that this can be done only by the increased use of preoperative bronchography. It is hoped that the advent of Dionosil, and the demonstration that it can be used safely in active pulmonary tuberculosis, will stimulate interest in the subject.

Fifteen roentgenograms.

**Regressive Giant Bullous Emphysema in Tuberculosis of Adults.** Donato G. Alarcon. Dis. of Chest **27**: 31–43, January 1955.

A number of reports have recently appeared, chiefly in the European and South American literature, of giant emphysematous bullae developing in the parenchyma of the lungs of tuberculous patients receiving chemotherapy, particularly Isoniazid. These lesions subsequently regress and disappear. For the occurrence of this syndrome the simultaneous presence of several factors is essential: extensive parenchymal destruction with a patent bronchus which allows expulsion of caseous material; constriction of the blood vessels to the area as a result of neural interference; fixation of the peripheral lung, most likely by pleural adhesions. Measurement of intracavitary pressure has proved the patency of the bronchi. Surgical exploration has shown the pleura to be adherent to the chest wall, and microscopic examination of resected specimens has shown the cavities to be lined by thin connective tissue.

Regression of the bullae occurs with re-expansion of the normal parenchymal tissue at the time of restitution of parenchymal vessels. The development and disappearance of these large bullae are well demonstrated by a case report and accompanying laminagrams. Twenty-six cases from the literature are discussed.

Eleven roentgenograms.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Asymptomatic Bronchogenic Carcinoma.** Robert P. McBurney, John W. Kirklin, and Robert T. Hood. Ann. Surg. **141**: 84–86 January 1955.

To test the validity of the widespread impression that bronchogenic carcinoma is usually curable if diagnosed and excised before symptoms develop, the authors undertook a review of 29 cases of truly asymptomatic bronchogenic carcinoma found among approximately 1,600 proved bronchogenic carcinomas at the Mayo Clinic.

The asymptomatic cases were all initially discovered by x-ray examination. Twelve cases were manifested by a "well-circumscribed" lesion, 10 by a "rounded nodular" lesion, and the remainder by areas of irregular density. The lesions were situated peripherally in 21 cases, in the mid-pulmonary fields in 6 cases, and centrally in 2 cases. They averaged 3 to 4 cm. in diameter. All were regarded as operable.

Apparently confirmed were the observations of McDonald and co-workers (J. Thoracic Surg. **22**: 63, 1951), who showed that small-cell and squamous carcinomas are usually centrally located and practically always asymptomatic, that adenocarcinomas are most often found in a peripheral location, and that large-cell carcinomas are usually fairly even in distribution.

The mortality rate was disappointingly high in this series, death occurring in 14 cases. The development of distant metastases in 6 of these patients, as against supraclavicular lymph node metastases in only 1, suggests that in asymptomatic carcinomas blood-borne metastases are more to be feared than lymph-node metastases.

The better results of treatment in asymptomatic bronchogenic carcinoma as compared with bronchogenic carcinomas in general are attributed to the high rate of resectability of the former. The authors suggest that if all cases of bronchogenic carcinoma in which resection was possible were compared with those in this series, probably little difference in treatment results would be found.

One table. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Contribution to the So-Called Alveolar-Cell Carcinoma (Pulmonary Adenomatosis).** E. Langer and K. H. Willmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 64–70, January 1955. (In German)

Pulmonary adenomatosis occurs mostly in the fourth and fifth decades of life and shows a predilection for the female sex. There are a fulminating form terminating after one to four months and a chronic protracted form lasting up to five and even six years. Histologically, there is a single layer of mucus-forming high cylindric cells coating the otherwise unaltered alveolar wall. Metastatic spread is rare but has been found in regional lymph nodes, liver, adrenals, brain, and skeleton. The incidence is only one thousandth that of bronchogenic carcinoma.

A case is reported in a female of 56 years, with a two-year history of recurrent afebrile pleurisy and foamy sputum. There were an increased erythrocyte sedimentation rate, dyspnea, dullness over the right lower chest posteriorly, and diminished breath sounds. Roentgenograms revealed diffuse clouding of the right lower lobe posteriorly, and bronchography showed a wavy appearance of the right lower lobe bronchi, with non-filling of the superior segment branches. Bronchoscopy disclosed widening of the carina and inflammatory changes in the right lower lobe. A Papanicolaou smear was inconclusive. A lobectomy established the diagnosis of pulmonary adenomatosis. The course was downhill and the patient died elsewhere sixteen months later.

In the differential diagnosis, one must consider coccidioidomycosis, histoplasmosis, chronic pneumonia, and metastatic lesions. No effective therapy is available and the outcome is always fatal.

Two roentgenograms; 1 photograph; 1 photomicrograph. ERNEST KRAFT, M.D.
Newington, Conn.

**Alveolar Carcinoma of the Lung (Pulmonary Adenomatosis).** R. Pohl. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 70–73, January 1955. (In German)

Alveolar-cell carcinoma or pulmonary adenomatosis, although known by pathologists for eighty years, is still rare and has only in recent times been recognized as a roentgenologic entity. A case is described in a female, aged 59, with a six weeks history of fatigue, loss of appetite, back pain, spastic cough producing large amounts of foamy sputum, and an ever increasing dyspnea. Roentgenologically, there was diffuse clouding of the right lower lung field which faded toward multiple small coalescent foci higher up. Peribronchial thickening was seen throughout both lungs. The patient died after two weeks, and at autopsy pulmonary adenomatosis was found, with lymphatic spread to the pleurae. There was also metastatic lymph node involvment on the left side of the neck and a purulent, hemorrhagic pericarditis.

Pulmonary adenomatosis shows usually an insidious onset and a long protracted course, terminating fatally after many months or even years. In this case the short duration of only eight weeks was unusual.

The author believes that the disease has a multicentric origin rather than a single focus with a bronchogenic spread. The histologic picture is that of a columnar-cell carcinoma originating in the alveolar structures. The disorder has a constitutional-hereditary origin. A suspected virus nature has never been proved. Therapy is not discussed in this paper.

One roentgenogram; 1 photograph.

ERNEST KRAFT, M.D.
Newington, Conn.

**Philadelphia Pulmonary Neoplasm Research Project. Preliminary Report.** Katharine R. Boucot, William Carnahan, David A. Cooper, Thomas Nealon, Jr., Donald J. Ottenberg, and Peter A. Theodos. J.A.M.A. **157:** 440–444, Jan. 29, 1955.

In order to study the characteristics of "curable" cancer of the lung, the Philadelphia Pulmonary Neoplasm Research Project was set up on Dec. 4, 1951. The plan calls for following 6,000 men forty-five years of age and older by 70-mm. photofluorograms, both inspiratory and expiratory, every six months for a period of ten years. A questionnaire covering symptoms and smoking habits is completed at each visit. After a follow-up period of four to thirty-four months, 37 proved lung cancers were detected among the 3,945 men who entered the study during the first two and one-half year period. Not one of these occurred among the 559 non-smokers.

Six tables.

SHOZO IBA, M.D.
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**Pulmonary Arteriovenous Telangiectasis.** Fred N. Mitchell. South. M. J. **47:** 1157–1161, December 1954.

Seven cases of pulmonary arteriovenous telangiectasis are presented, bringing the total number of cases recorded to approximately 87, with 33 giving a history compatible with familial hemorrhagic telangiectasis. The importance of the family history is emphasized. The nephew of one of the author's patients had a similar lesion; this is the first case reported in a relative more distant than parents, offspring, or siblings. One of the other cases was unusual in that the telangiectasia occurred in the apical portion of the lung; involvement of this region has not previously been reported.

Although the Valsalva and Mueller maneuvers are positive in perhaps only 50 per cent of cases, they are extremely valuable, and x-ray studies should not be considered complete without them. Angiography should be done preoperatively to demonstrate the true extent of the lesion and to reveal other lesions not recognizable by the usual procedures.

Two roentgenograms; 1 chart; 1 table.

**A Case of Cryptococcosis with Involvement of Lungs and Spine.** David Eisen, Israel Shapiro, and J. B. Fischer. Canad. M. A. J. **72:** 33–35, Jan. 1, 1955.

A case of cryptococcosis with involvement of the lung and spine is presented. This is believed to be the first case of its kind to be reported in Canada. The patient was a 29-year-old white woman with a nagging pain in the middle of the lower back and a plum-sized, pinkish swelling, warm to the touch, directly over the third lumbar vertebra. X-ray examination showed a destructive lesion, ovoid in shape, occupying the upper posterior quadrant of the spinous process directly beneath the soft-tissue swelling. There was no periosteal or bony reaction. The lesion was thought to represent a localized subchronic or reactivated osteomyelitis of the spinous process. Though there were no symptoms referable to the chest, a routine roentgenogram showed a generalized involvement of both lungs by a soft infiltration, peribronchial in distribution and extending from the clavicles to the domes of the diaphragm, leaving the apices and the costophrenic angles clear. The basic nodules were somewhat irregular in shape and size and showed a tendency to conglomeration peripherally into bean-shaped fluffy masses. The infiltration was evenly distributed on both sides and fanned out from the hilus, although the hilar shadows themselves were not enlarged.

The mass over the lumbar spine was aspirated and about 3 c.c. of blood-stained, thick yellow pus was obtained. Culture revealed *Cryptococcus neoformans*. Eleven days later the abscess was again aspirated and 50 c.c. of pus obtained. The patient was placed on sulfadiazine; the response was prompt and within ten days the sedimentation rate fell from 60 to 10 mm. The ultimate results in this case are uncertain, but six years after the onset of her illness the patient was in good health.

Two roentgenograms; 1 photomicrograph.

**Pulmonary Appearances in Polyarteritis Nodosa.** Basil Strickland. J. Fac. Radiologists **6:** 201–208, January 1955.

The number of diseases which polyarteritis nodosa can simulate is legion, and diagnosis is often difficult. Biopsy of a skin nodule is the most accurate diagnostic procedure but, since such nodules are not always present, muscle biopsy (particularly of a tender area) is usually performed. It follows that the part that radiology can play in the diagnosis of polyarteritis nodosa is necessarily limited. Changes are most commonly seen in the lung fields, by far the commonest being those due to cardiac failure, so often a terminal event in this condition. Changes other than those directly attributable to cardiac failure are rare.

Six proved cases of polyarteritis nodosa are presented. The radiologic findings in these cases seemed to have no common fundamental pattern. Although an autopsy was done on 4 of the cases, it is not possible to be in any way dogmatic concerning the immediate underlying pathologic process which may have given rise to the roentgen changes.

One patient (Case I) is alive and well. At necropsy the lungs in Case II showed a diffuse and well healed arteritis similar to a necrotizing arteritis present in the kidneys and considered to be typical of polyarteritis nodosa. Pulmonary fibrocaseous disease was also present and was thought to be tuberculous in origin, although repeated attempts to identify acid-fast organisms were of no avail. Either two different conditions were present in the lungs simultaneously in this instance, *i.e.*, polyarteritis nodosa and tuberculosis, or else all the changes present were secondary to the necrotizing arteritis.

Cases III, IV, and V all showed a well marked eosinophilia in the peripheral blood count during life, but not only were the roentgenograms quite unlike one another, but they also bore little resemblance to the picture usually described under the term "pulmonary eosinophilia."

The lungs in Cases III, IV, and VI all contained

multiple granulomata postmortem, but in the last case a roentgenogram of the chest taken one week before death showed no specific lesion which could definitely be attributed to a widespread granulomatosis, unless the basal striations were in part due to this underlying change.

The only persistent clinical feature common to all 6 cases was a well marked respiratory illness dominated by cough and dyspnea, but only in Case I were the symptoms truly asthmatic in type.

It would seem from the postmortem and hematologic findings *in vivo* in this small series and a review of the scant literature on the subject that pulmonary eosinophilia and pulmonary granulomatosis are the two most likely factors producing the pulmonary opacities in polyarteritis nodosa, but multiple small infarcts and lobular atelectases may account for some of them.

From the radiologic point of view one may draw attention to the bizarre nature of the opacities, their transient nature, and their tendency to appear first at one site and then at another, often progressing in one lung field while simultaneously regressing in the other, usually leaving a normal appearance once resolution is complete. The opacities may coalesce or remain discrete; they may be dense and homogeneous or of extremely low density and irregular. The very lack of pattern seems almost a typical feature in itself.

While the commonest radiological findings in polyarteritis nodosa are those due to cardiac failure with or without pulmonary edema, the changes described by the author should be borne in mind in any undiagnosed condition presenting bizarre symptoms and signs, where the clinical possibility of polyarteritis nodosa may arise.

Fourteen roentgenograms.

**Chest X-ray Findings and Some Clinical Aspects in Pulmonary Paragonimiasis.** Sze-Piao Yang, C. S. Cheng, and K. M. Ghen. Dis. of Chest **27**: 88–95, January 1955.

Although previous studies have failed to show significant abnormalities on chest roentgenograms of patients with pulmonary paragonimiasis, the authors obtained abnormal roentgenograms in 88 of a series of 100 cases diagnosed by the demonstration of ova in the sputum.

The most frequent abnormality was the presence of nodules varying from 0.5 to 4.0 cm. in diameter, most commonly in the mid-portion of the lungs. These nodules were usually seen in chronic cases and did not disappear on repeated examination. This finding was present in 59 patients. Ill-defined or hazy opacities were seen in 29 patients. These were more frequently found in the early stage of the disease and tended to disappear or decrease in size, leaving residual nodules. They are thought to be a non-specific inflammatory or allergic reaction. Pleuritic changes were observed in 30 cases, occurring most frequently in the early stage, when the larvae were still penetrating the diaphragm into the pleura. At this stage the sputum was most often negative. Pneumothorax was present in 4 patients and was always accompanied by effusion or cloudy opacities within the lung. No definite cavitation was observed at any stage. The authors discuss also some of the clinical aspects of the disease and present 4 case histories.

Eight roentgenograms; 3 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Postoperative Bronchopathies.** P. Mounier-Kuhn, J. De Rougemont, A. Persillon, and R. Bresson. J. franç. méd. et chir. thorac. **9**: 78–81, 1955. (In French)

Postoperative bronchial complications are especially troublesome after pulmonary and abdominal surgery. Of 27 patients studied by the authors, 16 were men and 11 were women; 16 were between the ages of twenty and forty years. All of the complications occurred between Oct. 1 and March 31, the cold and humid season; 56 per cent developed within forty-eight hours after surgery, and 67 per cent within twenty-seven hours.

Four clinical forms are described. Flooding of the bronchial tree (drowned lung) usually occurs in the first forty-eight hours and is characterized by dyspnea, gurgling noises in the tracheobronchial tree, fever, and cyanosis. Bronchial aspiration is important in treating this condition. A second form, often found after abdominal surgery in patients with previous catarrhal inflammations, is of slower evolution. The secretions may not be so abundant, but may be tenacious. Fever and dyspnea slowly increase. The third form is a progressive bronchial disease occurring especially after operations on the lung. There is difficulty in elimination of bronchial secretions. The course may be acute, with pronounced dyspnea and fever. Bronchoscopic aspiration ameliorates the symptoms, but may have to be repeated. The fourth clinical form is termed the paralytic bronchial syndrome. The patients in this group have localized thoracic pain and rapidly mounting fever. The roentgenogram shows atelectasis. Bronchoscopy reveals a bronchial paralysis, with non-evacuated secretions forming a mucous plug.

In all of the clinical forms described, bronchoscopic aspiration forms an indispensable part of the treatment.

CHARLES M. NICE, JR., M.D.
University of Minnesota

**Pleurisy and Pleuritic Residua, a Quantitative Consideration.** A. J. Rösli and K. Schaub. Radiol. clin. **24**: 36–44, January 1955. (In German)

In an effort to determine whether any relationship exists between the severity of an initial pleural effusion and the eventual changes induced in the chest by this effusion, a series of 78 uncomplicated cases were studied after a period of observation ranging from six to seventeen years. Because of the obvious difficulty in dividing the cases into several groups on the basis of severity, all 78 were arranged serially according to the extent of the shadow, thereby forming a continuous "intensity series," from 1 to 78. The position of a given case in the initial observation series was compared with its position in the final observation series. No case was included that showed progressive parenchymal disease or in which surgical intervention was employed.

The results of comparison of these two "intensity series" are presented in graphic form. The following observations were made:

1. The left pleural space was involved 29 times, the right side 49 times, and both sides 14 times.

2. Women showed a peak frequency of the initial effusion between the twenty-fifth and thirtieth year, and a much smaller peak in the climacteric.

3. Males showed a similar age distribution, but their peak was between the twentieth and thirtieth year.

4. Both sexes showed an increased incidence during and directly after World War II.

5. The patients with more than a ten-year observation period showed, in general, a higher position (worsening) in the final "intensity series," while patients with less than eight years observation showed a slight tendency toward improvement. But there were many exceptions to this rule.

6. Of patients under the age of thirty-nine, 27 showed improvement, while an equal number were worse in the final "intensity series." Qualitatively, however, the tendency toward worsening was essentially smaller than the tendency toward improvement. The reverse was true of patients of forty and over at the time of the first observation: 13 had become worse and 6 had improved on the final "intensity series," though qualitatively the tendency toward worsening was much greater than toward improvement.

Six tables.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Calcification of the Pleura.** L. R. Sarin. J. Indian M. A. **24:** 293–294, Jan. 16, 1955.

Two cases of calcification of the pleura are reported. One patient was asymptomatic, and the calcification was detected only on routine roentgenography; there was a history of pleurisy eight years previously. The other patient presented the picture of congestive heart failure secondary to chronic cor pulmonale. He complained of cough of two and a half years duration, dyspnea on exertion for one year, edema of the feet and abdomen for two and a half months. Eighteen months previously he had pain in the left chest with fever and cough, lasting fifteen days. Roentgen examination revealed calcification of the left pleura. Rest and mercurial diuretics produced prompt relief of symptoms.

**The Use of Tomography in the Paramediastinal Pleura Following Gas Insufflation of the Mediastinum.** Graziano Pidone and Gaetano Cosentino. Ann. di radiol. diag. **27:** 108–131, 1954. (In Italian)

Insufflation of the mediastinum may be accomplished by injecting gas posterior to the trachea after a low cervical transtracheal puncture. This insufflation and the use of tomography for the dissociation of the various shadows was found useful by the authors for the study of the paramediastinal pleura. Normally the paramediastinal pleura becomes visible, after insufflation, as thin lines on each side of the vascular pedicle. In pathological cases the authors find that the paramediastinal lines are greatly thickened or that no visualization can be obtained because of the firm adhesion of the pleural lining to the underlying tissues. This adhesion does not permit the gas to infiltrate the subpleural space.

Nineteen roentgenograms.

CESARE GIANTURCO, M.D.
Urbana, Ill.

## THE CARDIOVASCULAR SYSTEM

**The Left Lateral Oesophagram in Mitral Valvular Disease.** J. M. McKay and J. D. Aitchison. J. Fac. Radiologists **6:** 209–213, January 1955.

The authors describe a study of 55 cases of rheumatic disease of the mitral valve which was undertaken to compare the value of the left lateral and right oblique views in the demonstration of left atrial enlargement. A study was also made of the value of the left lateral view in assessing the size of the left ventricle. The criteria for inclusion in the series were: (1) definite clinical evidence of mitral valve disease; (2) absence of severe chest deformity (cases with depression of the sternum were included unless there was significant displacement of the heart); (3) absence of conditions causing elevation of the diaphragm, such as ascites, pregnancy, etc.; (4) demonstrable left atrial enlargement in either the right oblique or the left lateral esophagram.

During routine fluoroscopy, in addition to the conventional postero-anterior and oblique views, a left lateral view was taken in full inspiration with the esophagus outlined by barium sulfate, at a distance of 6 feet. As far as possible a distended esophagus was avoided, as distention tends to obscure the degree of displacement.

The degree to which left atrial enlargment was evident was compared in the right oblique and left lateral views in each case. In 25 of the 55 cases studied there was no appreciable difference. In 3 cases enlargement of the left atrium was more obvious in the right oblique view; in 27 the left atrial enlargement was more obvious in the lateral view. In 1 instance the right oblique view was negative while the left lateral view was suggestive of left atrial enlargement. These results confirm the findings of Jacobson *et al.* (Am. Heart J. **43:** 423, 1952. Abst. in Radiology **60:** 122, 1953) that the left lateral view is superior to the right oblique for demonstrating enlargement of the left atrium.

Jacobson and his co-workers mentioned that left ventricular enlargement could be recognized in some of their cases by displacement backward of the lower thoracic esophagus. During scrutiny of the left lateral views in the present series, the authors observed that in some cases there was an obvious translucent space between the posterior lower left ventricular margin and the esophagus, while in others the left ventricle extended backward as far as the esophagus or displaced it backward, thus obliterating this space. In their experience the translucent space is usually present in pure mitral stenosis (80 per cent of the present series), whether or not the heart is enlarged. Where there was an associated valvular lesion capable of causing left ventricular enlargement the space was present in 45 per cent.

Four roentgenograms.

**Radiology of the Lung in Severe Mitral Stenosis.** D. S. Short. Brit. Heart J. **17:** 33–40, January 1955.

The lung changes in 33 patients with severe mitral stenosis are analyzed by the author with respect to the hilar shadows, parenchyma, and pleura. In no instance did the mitral orifice, measured at surgery or autopsy, exceed 1.0 cm. in length. Several patients had minor degrees of mitral or aortic incompetence but in no case did the electrocardiogram or fluoroscopy suggest left ventricular enlargement.

"Clouding" of the hilar shadows, with poor definition of the pulmonary vessel walls and the bronchial lumen, was present in 30 of the 33 cases, the changes being marked in 14 and moderate in 16. Twenty-three of the 30 patients with abnormal hili also showed some loss of radiolucency in the perihilar zone. The sharp borders

of the ribs and heart as well as the pulmonary vessels are lost. This loss of radiolucency is due to an abnormal profusion of vessels 0.5 to 2 mm. in diameter.

"Septal lines," short linear shadows from 0.3 to 1.0 mm. wide and 5 to 15 mm. long, occurring peripherally at right angles to the pleura, especially in the costophrenic angles, were present in 25 cases. They are produced by thickening of interlobular septa. Narrowing of the pulmonary arteries, indicating pulmonary hypertension, was definitely present in 2 patients and considered borderline in 4 others. In most cases the vascular pattern could not be evaluated because of the clouding mentioned above. One large and one small pleural effusion were seen and in 12 cases there was some thickening of the interlobar fissures.

Several patients were observed over a period of years, and the various abnormalities fluctuated with changes in cardiac status, diminishing at times but never disappearing and showing an overall tendency to progression.

Since one or more of the abnormalities described was found in every one of the 33 patients, it is concluded that a normal lung pattern rules out severe mitral stenosis.

Eight roentgenograms; 1 diagram.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Pulmonary Hemosiderosis in Mitral Stenosis.** H. E. Taylor and G. F. Strong. Ann. Int. Med. **42:** 26–35, January 1955.

The presence on chest films of miliary or nodular pulmonary opacities has occasionally been described in cases of mitral stenosis with chronic venous congestion of the lungs. These have been ascribed to hemosiderin deposits with surrounding tissue reaction. The authors, by meticulous tissue studies in 45 fatal cases of mitral stenosis, have shown that, instead, the nodules are usually formed by aggregates of siderophages. These are hemosiderin-containing phagocytes which, in sufficiently large nodular accumulations, are opaque to x-rays and may appear as miliary densities in the chest films. Such nodules were found in 42 per cent of the cases examined and were apparent on 29 per cent of the available films from the series.

The nodules are believed to be due to small repeated hemorrhages occurring within the alveoli anywhere in the lung, principally as a result of venous congestion and pulmonary hypertension. Further emphasizing the role of pulmonary hypertension is the fact that nodular hemosiderosis is more frequently seen radiographically in cases which exhibit right ventricular hypertrophy.

To be differentiated are denser opacities caused by small calcified or bony nodules sometimes observed in such cases and believed to be an end result of rheumatic pneumonitis. These are unrelated to the siderophage accumulations, which contain no stainable calcium.

Five photomicrographs; 4 tables.

DON E. MATTHIESEN, M.D.
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**Ebstein's Anomaly: Report of a Case Diagnosed During Life.** A. J. Kerwin. Brit. Heart J. **17:** 109–112, January 1955.

Less than 50 cases of the malformation and displacement of the tricuspid valve comprising Ebstein's anomaly have been reported. The author presents a case diagnosed during life and confirmed postmortem. Findings on the plain film and on electrocardiography were typical—gross enlargement of the right heart, a small left heart and aorta, decreased vascularity of the lungs, right bundle branch block, and delayed auricular-ventricular conduction. [Angiography, which may reveal the anatomical relationships, is not mentioned.] Catheterization proved that the enlargement was confined to the right atrium, since a ventricular pressure curve was not obtained until the tip was positioned near the cardiac apex. Eleven weeks later the patient died suddenly and at autopsy the malformation was found. Anatomically the case was unusual in that the musculature of the right atrium and proximal right ventricle was hypertrophied rather than atrophied and there was no atrial septal defect.

The significance of making the diagnosis lies in the avoidance of needless and dangerous surgery, since nothing can be done for these patients at the present time.

One roentgenogram; 2 photographs.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

**Aortic Sinus Aneurysm Associated with Coarctation of the Aorta.** William Dubilier, Jr., Thomas L. Taylor, and Israel Steinberg. Am. J. Roentgenol. **73:** 10–14, January 1955.

A hitherto undescribed finding in patients with coarctation of the aorta, namely, a localized symmetrical aneurysm or dilatation of the aortic sinuses, was found by the authors in 3 of a series of 58 patients examined by angiocardiography. The 3 patients were males of seventeen, eighteen, and twenty years. These aneurysmal dilatations are to be distinguished from syphilitic, mycotic, and congenital aneurysms. Those associated with coarctation are diffuse enlargements of the aortic sinuses, while in the other conditions named there is an outpocketing into the ventricular wall with a small opening from the aortic sinus. In none of the patients could the aneurysm be seen in conventional films.

The authors feel that aneurysm of the aortic sinuses is probably more common in coarctation than has been appreciated in the past. Hamilton and Abbott (Am. Heart J. **3:** 381, 1928) reported that 22 per cent of patients with coarctation died of rupture of the aorta, and it is believed that in the presence of an aneurysm proximal to the coarctation the likelihood of rupture would be increased because of weakening of the wall. The demonstration of such an aneurysm, therefore, suggests a serious prognosis. The authors also regard it as an indication for surgical repair of the coarctation. However, in the single patient in their series in whom operation was done, there was no change in the configuration or size of the aneurysm as seen by angiocardiography after six months, although there had been a drop in the blood pressure.

Eight roentgenograms; 4 drawings.

RICHARD G. LESTER, M.D.
University of Minnesota

**Aortic Sinus Aneurysm. Production of Intracardiac Calcification and Pulmonary Artery Fistula.** Joseph C. Shipp, Leonard V. Crowley, and Russell Wigh. Am. J. Med. **18:** 160–176, January 1955.

The authors present a case of syphilitic aneurysm involving the left aortic sinus which produced a roentgen configuration similar to that seen in mitral valvular disease and ruptured into the pulmonary artery.

Radiologic studies showed an enlarged heart with a

prominent pulmonary artery segment. A thin annular ring of calcium was seen within the cardiac shadow, which displaced the esophagus posteriorly and to the right. This was interpreted as an enlarged, calcified left auricle. The ascending aorta was not dilated or calcified.

At autopsy a large saccular aneurysm about 9 cm. in diameter was seen to arise from the left aortic sinus and adjacent ascending aorta. It had expanded posteriorly and laterally to encroach upon the left auricle. There was calcification in the wall and a laminated thick thrombus internally. The aneurysm compressed the pulmonary artery and eroded into it proximal to the bifurcation, with the formation of a fistula.

The erosion of the aneurysm into the pulmonary artery with development of the fistula resulted in an acute episode of severe dyspnea six weeks prior to death.

Three roentgenograms; 1 drawing; 3 photographs.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

**Unilateral Clubbing of the Fingers Due to Absence of the Aortic Arch.** E. R. Dorney, N. O. Fowler, and E. P. Mannix. Am. J. Med. **18:** 150–154, January 1955.

A case report of unilateral clubbing of the fingers due to absence of the aortic arch is presented. The blood supply to the right upper extremity came through the aortic remnant while the left arm and remainder of the body were supplied through a wide patent ductus opening into the descending aorta.

The patient was a 5-year-old girl with congenital heart disease which was thought from catheterization data, electrocardiograms, and roentgen studies, as well as physical findings, to be due to patent ductus with pulmonary hypertension and reversal of flow. Clubbing and cyanosis of the left hand and both feet were present, but the right hand was normal. Roentgen studies showed increased vascularity of the lung fields with no intrinsic pulsations of the vessels. There was marked enlargement of the pulmonary artery and right ventricle. Angiocardiograms were unsuccessful.

At operation the right ventricle and pulmonary artery were enlarged, the latter into an arterial trunk that gave off both pulmonary branches and the left subclavian artery and continued into the descending aorta. The aorta was a small vessel that arose from the normal site and coursed into the neck without connection to the pulmonary artery or descending aorta. No surgical correction was attempted.

The embryology of the anomaly is discussed, as is the altered physiology. It is postulated that the fetal type of circulation remained, with progressive right ventricular hypertrophy and compensatory changes in the pulmonary vascular bed. An interventricular septal defect must also have been present to serve as passageway for oxygenated blood from the left heart to the descending aorta.

Two roentgenograms; 1 photograph; 2 drawings.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

**Aortography.** J. Sydney Ritter. J. Urol. **73:** 155–161, January 1955.

The author describes his technic for translumbar aortography. An ordinary 8-inch No. 17 or 18 gauge styleted needle, a Luer-Lok 20-c.c. syringe of normal caliber, and 80 per cent sodium iodide solution are used. Following local anesthesia with 1.0 per cent procaine, the needle is introduced at the junction of the outer border of the lumbar muscles and the lower border of the twelfth rib and aimed toward the aorta to enter it at the level of the lower border of the first lumbar vertebra. Ten cubic centimeters of the warmed sodium iodide solution is rapidly injected and an exposure is made.

When Urokon, Neo-Iopax or Diodrast is used, the patients are given 50 mg. of Benadryl prior to the injection to decrease sensitivity to these media. With high-strung individuals a short pentothal sodium intravenous general anesthesia is induced.

While the author regards translumbar aortography as a valuable procedure, he points out that it is also a formidable one and not to be used indiscriminately. Because of the need for speed, precision, co-operation, and accuracy, a trained team is required.

The indications for aortography are illustrated by reports of cases in which the procedure was of value. These include:

1. Renal tumors. It is the author's opinion that all renal cysts demand exploration to rule out the possibility of cancer and that aortography is of inestimable value in studying these patients.
2. Renal agenesis.
3. Renal ptosis. The author believes that nephralgia may be due to a tug on the renal vessels and aortography may demonstrate this.
4. Atrophic pyelonephritis.

Also described is a case in which aortography demonstrated the presence of new vessels in a kidney following nephro-omentopexy.

No fatalities due to aortography have been encountered by the author. One hypertensive patient had gross hematemesis immediately following the procedure, attributable to a reaction to the iodide in the gastric mucosa.

When contrast media other than sodium iodide are used, x-ray exposures are made three, seven, and ten minutes after the aortogram is obtained, for the purpose of obtaining an excretory urogram.

Six roentgenograms.

WILLIAM THORWARTH, M.D.
University of Pennsylvania

**Radiological Visualization of the Coronary Arteries in the Living Subject. Results of 413 Observations.** Lucio Di Guglielmo and Mario Guttadauro. Radiol. med. (Milan) **40:** 945–975, October 1954. (In Italian)

The authors have performed thoracic retrograde aortography by means of catheter injection 199 times and report no accidents from this procedure. They review their experience and state that the deaths attributed by others to the examination were due to errors in technic, the tip of the catheter being either too low (direct injection in the coronaries) or too high (too much medium in the cerebral circulation).

The authors performed aortography for such indications as patent ductus, coarctation of the aorta, mediastinal tumors, and various congenital defects. They obtained excellent visualization of the coronaries in 144 instances. Their series included no case of coronary disease, but they do not state whether they consider this a contraindication to the procedure.

Essentially the patients examined by the authors had normal coronary arteries. They thus afford an interesting study of the normal coronary system and of possible anomalies. Anomalies were not infrequently

observed. While in most patients the left coronary artery is considerably larger than the right, occasionally the reverse is true. There are also numerous cases showing anomalies of distribution or of origin of the various branches.

The accumulated knowledge of the normal coronary system will be of great value when it becomes possible to perform such studies in patients affected by coronary disease.

Twenty-nine radiographs of excellent quality are reproduced, with accompanying drawings labeled for easy interpretation. CESARE GIANTURCO, M.D.
Urbana, Ill.

**Total Anomalous Pulmonary Venous Drainage.** George Miller and Byron E. Pollock. Am. Heart J. **49**: 127–134, January 1955.

A 24-year-old soldier was admitted to the hospital for investigation of a "mediastinal mass" which was observed on a routine roentgenogram made prior to his separation from the Army. He had no complaints and was unaware of cyanosis or clubbing. Physical examination, however, revealed mild but definite cyanosis of the fingers, toes, lips, and ears, together with clubbing of the fingers and toes. The heart appeared enlarged to the left. There were no thrills. A Grade 2 blowing systolic murmur was heard over the entire precordium, with maximal intensity in the third and fourth left intercostal spaces parasternally. A faint short diastolic murmur was also heard in this area.

Laboratory studies revealed a normal white and differential count; hemoglobin 20.8 gm. per cent; red cells 6,020,000; hematocrit, 67 per cent. Decholin circulation time was seven seconds. The electrocardiogram demonstrated an incomplete right bundle branch block. A roentgenogram showed an increased transverse diameter of the heart, a prominent pulmonary artery segment, and increased pulmonary vascular markings. In the superior mediastinum was a large ovoid mass bulging into both lung fields. On fluoroscopy, the cardiac enlargement was seen to be right-sided. The pulmonary artery branches showed expansile pulsation. The borders of the mediastinal mass were quietly pulsatile, and roentgenkymographic examination revealed that they were not in phase with the pulsations of the aorta or pulmonary artery.

Angiocardiograms obtained with 50 c.c. of 70 per cent Diodrast were interpreted as showing a dilated superior vena cava; dilatation of the right atrium and ventricle, and pulmonary arteries; communication between the right atrium and left atrium; all the pulmonary veins draining into the right superior vena cava by way of the left innominate vein. The superior mediastinal mass observed on the conventional roentgenogram was seen to be formed by the large dilated superior vena cava on the right side and by a common pulmonary venous trunk on the left side.

Cardiac catheterization studies made subsequently revealed a marked left-to-right shunt into the right superior vena cava with oxygen saturation 99.3 per cent at one site. There was also evidence of a right-to-left shunt, with a peripheral arterial blood oxygen saturation of 87 per cent.

In approximately half of the cases of total anomalous pulmonary venous drainage, the heart and mediastinal shadow present a characteristic roentgenographic appearance described as a figure of 8 or dumbbell. This characteristic picture is obtained when the total pulmonary drainage occurs *via* the left innominate vein into the right superior vena cava. It is not seen when the pulmonary veins empty directly into the right atrium or by way of the coronary or portal venous system.

Because of the absence of any associated cardiovascular anomalies in approximately 60 per cent of the cases of total anomalous pulmonary venous drainage, it would appear that surgical correction could be obtained by anastomosing the anomalous veins to the left atrium. Unfortunately, there is usually underdevelopment of the left atrium and its appendage, so that it is difficult to achieve an adequate anastomosis.

Four roentgenograms; 1 electrocardiogram; 1 table. HENRY K. TAYLOR, M.D.
New York, N. Y.

**Angiocardiographic Findings in Pulmonary Tumors.** Carlo Bompiani. Radiol. med. (Milan) **41**: 1–16, January 1955. (In Italian)

The author reproduces characteristic angiocardiograms obtained in the presence of pulmonary tumors and reports 10 cases.

Endothoracic arterial and venous changes with pulmonary neoplasms vary from simple compression with displacement, rigidity, and filling defects, to complete occlusion. Arteries are more resistant to such changes because of their anatomy and the greater pressure within their lumina.

The superior vena cava may appear rigid due to infiltration within its walls or enclosure by infiltrated lymph nodes. This is true also of the two main branches of the pulmonary artery. Suitable equipment can demonstrate absence or reduction of caliber of both arteries and veins during systole and diastole.

When the stage of complete occlusion of the major mediastinal veins has been reached, extensive collateral circulation can be visualized. Simultaneous bilateral injections of the contrast material will give a more complete representation of the mediastinal venous circuit than injection of either side alone.

The changes described are not pathognomonic for pulmonary neoplasms. As far as the veins are concerned, inflammatory thromboses should be excluded. Conditions in the mediastinal lymph nodes such as malignant lymphoma can displace, compress, and even occlude vessels by direct extension. Vascular occlusion may also be produced by benign expansive processes, as cysts, aneurysms, and retrosternal goiters.

Still other processes must be considered in changes of the pulmonary arteries: advanced silicosis as well as chronic inflammatory diseases such as tuberculosis and actinomycosis can cause occlusion.

Mediastinal venous invasion, occlusion of the pulmonary arteries, demonstration of mediastinal metastatic masses with compression and displacements, and pericardial invasion are all indications of inoperability, although at times a tumor declared inoperable may be found completely resectable at operation.

Ten roentgenograms with accompanying line drawings. CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Cavography and Mediastinal Pathology.** Jarro Rosati. Riv. ital. di radiol. clin. **5**: 24–50, January-March 1955. (In Italian)

Cavography is the angiographic visualization of the

superior vena cava with its tributaries (axillary, subclavian, jugular, innominate, and azygos veins). At least four serial roentgenograms are obtained, at intervals of a second or half-second after bilateral (preferably simultaneous) injection of 20–25 c.c. of 35–50 per cent iodine-containing contrast medium into the basilic or cephalic vein at the elbow, or into the jugular vein in children. Catheterization can be used, but entails an added risk. The procedure may demonstrate the following changes:

(1) *Congenital abnormalities*, such as left cava, two cavae, or the very rare left cardinal vein opening into the atrium through the coronary sinus.

(2) *Displacements* of the cava: (*a*) laterally, as a result of massive atelectasis, pleural effusion or thickening (fibrothorax), peritoneal effusion, kyphoscoliosis, thoracic surgery (thoracoplasty, pulmonary resection), agenesis of one lung, etc., or (*b*) anteroposteriorly or anterolaterally, due to mediastinal tumor (cyst, teratoma, lymphoma, thymoma, intrathoracic goiter) or vascular dilatation (aortic aneurysm, auricular ectasy). Isolated deviations of tributaries are related to less extensive space-occupying processes, as depression of the left innominate by a thyroid nodule or elevation of the right innominate by a dextroposed aorta.

(3) *Deformities*, due to (*a*) extrinsic pressure from benign tumors or other long standing processes or (*b*) intrinsic lesions of the wall, *e.g.*, infiltration by an adjacent malignant process, with rigidity of the wall or even filling defects of the polypoid type.

(4) *Dilatations* of the superior vena cava, usually related to congenital heart disease (tricuspid stenosis, pulmonary stenosis with large interventricular septal defect).

(5) *Obstructions* of the superior vena cava, caused by thrombosis superimposed upon extrinsic or intrinsic stenosis, resulting in collateral circulation, which may be superior, middle or inferior, as determined by the location of the thrombus in relationship to the confluence of the azygos.

Proper evaluation in any given case requires comparison of the information obtained by cavography with routine and body-section roentgenograms, as well as with the clinical and laboratory data.

Eleven roentgenograms; 13 diagrams.

E. R. N. GRIGG, M.D
Cook County Hospital, Chicago

**Hypertension in Infancy, with Anomalous Renal Artery. Diagnosis by Renal Arteriography, Apparent Cure After Nephrectomy.** C. Harrison Snyder, Roger B. Bost, and R. V. Platou. Pediatrics **15**: 88–91, January 1955.

Hypertension in infants and children is rarely "essential": this report illustrates the importance of searching diligently for the cause.

A 9-months-old boy was brought to the hospital because of vomiting since the age of six and a half months. On examination he was found to have a persistently elevated blood pressure of about 240/190, with higher levels in the lower extremities. Urinalysis revealed low specific gravity and albumin. An esophagram showed a possible right hilar mass compressing the esophagus, and this, together with the hypertension, led to suspicion of an "ectopic" pheochromocytoma. Thoracotomy was performed and no abnormal mass was found. After an uneventful postoperative course the child was discharged. He was readmitted a month later with persistent hypertension and albuminuria. Excretory and retrograde pyelograms were normal. Renal arteriograms obtained after retrograde injection through the femoral artery showed two renal arteries leading to the right kidney, both with berry aneurysms. The right renal parenchyma did not opacify. Right nephrectomy was performed, and the roentgenographic findings were confirmed.

It would seem that the aneurysms were congenital, and that the patient remained healthy until, from some unknown cause, thrombosis occurred in the lower right renal aneurysm, with the production of symptoms. The blood pressure fell to 105/60 within eight days after operation. Albuminuria disappeared and the specific gravity of the urine improved. Two years later the child was well, the urine was normal, and the blood pressure remained at about 90/60.

One roentgenogram; 1 photograph.

D. D. ROSENFELD, M.D.
Oakland, Calif.

**Percutaneous Angiography with Special Reference to Peripheral Vessels.** David Sutton. Brit. J. Radiol. **28**: 13–25, January 1955.

Observations are given on 250 patients on whom percutaneous angiography was performed for lesions of the extremities. The vessels of the arm are difficult to inject, but the subclavian and brachial arteries have been used. The abdominal aorta and femoral arteries are the simplest to puncture percutaneously; the popliteal relatively difficult.

The chief indications for percutaneous angiography are: obliterative vascular disease, emboli, aneurysms, angiomas, arteriovenous fistulas, and tumors. The diagnosis of these diseases is not difficult by ordinary clinical methods; angiography adds exact information as to location and extent.

In the leg, atheromatous vascular disease is usually found in the lower femoral artery. Sometimes in intermittent claudication the peripheral vessels are normal, in which event the disease involves the arteries in the pelvis. In the diabetics studied (number not stated) the atheroma was peripheral. The author believes that many diabetics have had unnecessarily high amputations which might have been avoided had angiographic studies been performed.

Angiography appears to offer evidence of malignant bone tumors, though absence of abnormal vessels does not indicate that the tumor is benign.

Forty-three roentgenograms; 1 photograph; 3 tables.

SYDNEY J. HAWLEY, M.D.
Seattle, Wash.

## THE DIGESTIVE SYSTEM

**Spontaneous Rupture of Oesophagus.** J. Roger Boulle. Brit. M. J. **1**: 25–26, Jan. 1, 1955.

A case of spontaneous rupture of the esophagus is reported. A 73-year-old woman suddenly experienced severe upper abdominal pain which rapidly spread to both sides of the lower chest and back. After thirty minutes she vomited a little blood-stained fluid and collapsed with pain. There was a long history of dyspepsia relieved by self-induced vomiting. When admitted to the hospital the patient was in a state of shock and in great pain. The tongue was stained with altered blood. There was marked surgical emphysema

of the front of the neck. Aeration of the lungs was equal, with no detectable effusion or pneumothorax. A provisional diagnosis of spontaneous rupture of the esophagus was made.

Three mouthfuls of barium mixture were then given and roentgenograms were obtained. These showed the Ryle tube, which had been introduced previously, folded on itself in the esophagus. The mediastinum was widened, with much free gas. There was slight collapse of the medial lung substance at both bases and a very little free pleural effusion on each side, but no pneumothorax. The barium was found to have passed into the posterior mediastinum to the left, at the level of the lower part of the body of the seventh thoracic vertebra. In view of the certainty of a fatal outcome without treatment, a right thoracotomy was undertaken. The left side of the lower esophagus could not be seen satisfactorily, however, and the tear was not located.

The patient died forty-eight hours after the operation. Postmortem examination revealed a vertical tear 2 inches long in the left posterior esophagus, the lowest part of the tear being $1^1/_4$ in. from the esophagocardial junction. In this case the barium escaped only from the uppermost part of the tear, giving the impression that it was perhaps smaller and higher than it was eventually found to be.

One roentgenogram.

**Stenosis of the Esophagus and Stomach Following the Ingestion of Corrosive Substances.** Byron G. McKibben and Samuel Lee. Arch. Otolaryng. **61**: 2–8, January 1955.

That cicatricial pyloric stenosis may complicate the ingestion of corrosive substances is not generally known. Acids damage mainly the gastric tissues, while alkalies exert their effect principally upon the esophagus; however, either may produce scarring severe enough to result in stenosis of one or both areas.

Four cases are presented in which there was both esophageal and pyloric stenosis following the ingestion of a corrosive: a strong alkali (lye) in 3 instances and a strong acid (HCl) in 1.

The authors supplement their case reports with a reference to a series of 202 cases reported by Gray and Holmes (S. Clin. North America **28**: 1041, 1948. Abst. in Radiology **53**: 138, 1949). The latter writers stated that concomitant esophageal and pyloric lesions are to be found in 20 per cent of cases of ingestion of either an acid or an alkaline corrosive.

Six roentgenograms; 1 drawing.

ROBERT B. CONGER, M.D.
University of Texas, Dallas

**Examination of the Superior Portion of the Stomach by Insufflation and Stereoscopy.** Giacomo Bianchi. Radiol. clin. **24**: 24–27, January 1955. (In French)

The difficulties of the radiologic examination of the upper half of the stomach are well known. The methods described in the literature have not been satisfactory in the author's hands. He has therefore devised a simple, practical, and cheap examination that is easy for both physician and patient.

As much sodium bicarbonate as will hold to the point of a knife is added to ordinary barium. After several swallows, if the gas in the stomach is not adequate, the same amount of tartaric acid diluted in a little water is given. The patient is put in the Trendelenburg position and rotated to cover the proximal part of the stomach with barium. The table is then elevated almost to the vertical and as quickly as possible, before the barium drains from the fundal region, stereoscopic studies are made. Visualization is better if the films are obtained in expiration. No reactions have been noted. The author uses this procedure routinely.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**The Differential Diagnosis of Benign Prolapse of Gastric Mucosa.** Jacob Lichstein. Ann. Int. Med. **42**: 44–58, January 1955.

The diagnosis of transpyloric prolapse of gastric mucosa into the base of the duodenal bulb today depends wholly upon the x-ray findings. Typically, a smooth, lobulated, umbrella-like or mushroom defect is seen in the base of the duodenum. This appearance often leads to diagnostic errors, as other abnormalities may at times present a similar picture.

Twelve illustrative cases are presented along with a rather comprehensive survey of various possibilities in differential diagnosis. The most common problem is that of differentiation between mucosal prolapse and gastric polyps. The most difficult problem is said to be the distinction between prolapse and antral gastritis. Prepyloric carcinoma and hypertrophic gastritis are still other differential possibilities. A diagnostic criterion which should prove useful is the constancy or inconstancy of the mucosal pattern in the distal stomach. Thus, true gastric mucosal prolapse, in contradistinction to polyps and gastritis, is a dynamic condition which spontaneously regresses and recurs from time to time.

The incidence of associated gastrointestinal bleeding is rather high. Symptoms are usually non-specific. In a significant percentage of cases duodenal ulcer, prepyloric ulcer, or hypertrophic gastritis is a concomitant finding. One case is cited in which the diagnosis of benign prolapse allayed the suspicion of a possible neoplasm, which later proved to be present.

When the diagnosis of prolapse of gastric mucosa is made, fractional gastric analysis and gastroscopic examination are regarded by the author as mandatory in order to rule out more definitely other possibilities.

Thirty-two roentgenograms; 1 drawing; 1 table.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Gastrointestinal Distention in Infants.** Alex Gerber. J. Pediat. **46**: 67–77, January 1955.

Roentgen studies were carried out on 13 children ranging in age from twelve days to six years to determine the source of gastrointestinal gas. A preliminary abdominal film was obtained following four to eight hours of fasting. The roentgenogram was repeated after thirty minutes of sucking on an empty bottle and a third was obtained after an oral intake of 15 to 120 c.c. of milk. These studies were interpreted as indicating that air is swallowed mainly during deglutition; little if any air is ingested while crying or sucking. The suggestion that infants normally ingest air during each inspiration has not been confirmed.

Seventeen roentgenograms; 2 tables.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Treatment of Acutely Perforated Peptic Ulcers. Radiological Diagnosis of Site of Perforation.** H. D. Moore. Lancet **1**: 163–169, Jan. 22, 1955.

The purpose of this paper is to recount the experience, results, and conclusions of one surgeon in the treatment, by different methods, of 125 acutely perforated peptic ulcers, and to describe a radiologic technic for locating the site of the perforation. Sixty-five of the ulcers were treated by aspiration, 45 by simple suture, and 15 by immediate partial gastrectomy. The author's conclusions are as follows: In patients who are in good condition on admission, (1) the mortality is the same whatever method is used; (2) the immediate morbidity of simple suture is much higher than that of aspiration; (3) the likelihood of recurrent or persistent ulceration is very great in those with a long history of dyspepsia. Fit patients should undergo immediate partial gastrectomy if they have a long previous dyspeptic history, but if they have had little or no dyspepsia they should be treated by aspiration. Patients who are ill on admission from the effects of the perforation will die if treated by aspiration or by gastrectomy; the ulcer should be sutured and the patient should be given vigorous resuscitative treatment. Patients who, on admission, are ill from an associated medical condition should be treated by aspiration.

*Radiologic Technic:* Instead of conventional roentgenography of the diaphragmatic region for gas, 30 ml. of viscous diodone (Viskiosol six) and 30 ml. of sterile water, or 40 ml. of 35 per cent diodone, is squirted down the suction tube or given by mouth. (Diodone and viscous diodone are used because they are water-soluble and soon absorbed.) Three films are then taken: one with the patient erect (this is developed and examined to see whether the exposure is correct, which takes about ten minutes); a second with the patient erect; and the third (immediately after the second), with the patient supine. Gastric suction is, of course, discontinued while this is being done.

Fifty-seven patients have been studied by the above technic. The stomach was well outlined in all cases. When the patient was well and without abdominal pain, *e.g.*, in routine out-patient radiography, the diodone passed rapidly into the duodenum and jejunum. However, in 48 cases in which there was acute abdominal pain the diodone passed out of the stomach in only 14, *i.e.*, there seemed to be a pyloric spasm in most instances.

Among the 22 patients in whom the diagnosis was confirmed, there were 19 with duodenal ulcer, and in only 6 of these had the contrast medium passed into the duodenum. In 2 of these the roentgenograms had shown escape of the diodone through the perforation. In the 13 cases in which the diodone was retained in the stomach, the duodenal perforation could not of course be demonstrated. Of 2 prepyloric ulcers, 1 had a tiny perforation only, and no medium escaped into either the peritoneum or the duodenum. In the second, the perforation measured 0.5 cm. in diameter and the escape of diodone permitted a preoperative diagnosis. In the single case of gastric ulcer, a large leak was seen.

In 7 of the 16 perforations demonstrated roentgenologically but not operated upon, the medium passed into the duodenum; 4 of these showed the Viskiosol escaping through the hole in the duodenum; in the other 9 the pylorus appeared to be in spasm.

Nine roentgenograms; 1 drawing; 4 tables.

**Primary Peptic Ulceration of the Jejunum.** S. Levitt and Eric G. Saint. Lancet **1**: 77–79, Jan. 8, 1955.

The case is reported of a young woman who was seen with symptoms of ulcer and in two years had at least five severe episodes of melena due to primary ulceration of the jejunum. The diagnosis was made at laparotomy undertaken for perforation of the bowel. When recurrence of ulceration, with further perforation and hematemesis, followed subtotal gastrectomy, it became necessary to remove the remainder of the stomach.

The repeated inability to demonstrate a lesion either gastroscopically or radiologically to explain the obvious symptoms of peptic ulceration was a source of perplexity for two years. In retrospect, the constantly observed dilatation of the duodenum and the absence of peristalsis of the jejunum in barium studies were of diagnostic significance. Even if jejunal ulcers are not themselves radiographically demonstrable, it seems that a diagnosis can be tentatively made, before dangerous complications develop, on the basis of a history of ulcer pain and the radiologic visualization of abnormalities of muscular tone in the duodenum and jejunum. A study of radiologic findings in previously reported cases supports this view. The nearer the ulcers lie to the duodenojejunal flexure, the closer do the symptoms simulate those of duodenal ulcer. The periodicity of pain, its relation to meals, and the relief obtained from acid-neutralizing agents were all characteristic of duodenal ulcer pain and suggest a similar mode of origin.

Treatment consists in excision of the affected jejunum. If preoperative studies reveal normal secretion of gastric hydrochloric acid, subtotal gastrectomy, in addition, will probably suffice. If severe hyperchlorhydria is present, total gastrectomy must be considered.

Six figures, including 2 roentgenograms.

**Pneumatosis Cystoides Intestinalis in Infancy.** Leonard Paris. J. Pediat. **46**: 1–17, January 1955.

Pneumatosis cystoides intestinalis is a distinctive morphologic entity of obscure origin and rare occurrence which is characterized by the presence of gas cysts within the bowel wall and sometimes within the adjacent mesenteric fat and regional lymph nodes. Clinically, it exhibits no specific or diagnostic symptomatology and has a bizarre age distribution in that it occurs predominantly in infants and middle-aged people. In the latter, the lesions are chiefly serosal in distribution, whereas in the former they occur for the most part within the mucosa and submucosa. The cysts represent lymphatic channels distended with gas.

An inflammatory reaction in the cyst walls is either absent or minimal in infants but is invariably present in adults, being essentially chronic in nature and often of foreign-body type. Pneumatosis occurring in infancy is always associated with acute enteritis, whereas in adults, although occasionally primary, it is most frequently seen with stenosing peptic ulcer, either gastric or duodenal, and less frequently with carcinoma of the stomach, intestinal tuberculosis, acute and chronic appendicitis, and enteritis and fibrous adhesive bands.

A case associated with congenital megacolon in a 5-month-old white male infant is presented. The author postulates that the pneumatosis originates as an enteritis of bacterial nature with considerable intraluminal gas production and alteration in mucosal permeability

to gas. The gas passes through the mucosa into the lymphatics of the submucosa and muscularis to reach the subserosal lymphatics. It then passes, *via* the lymphatics of the mesenteric fat, to enter the sinuses of the mesenteric lymph nodes. Some gas diffuses into the tissues and into the cisterna chyli and thoracic duct. The infantile type is interpreted as representing an acute process, so that the gas cysts are more superficially situated; in the adult type the lesion is of a chronic nature, allowing the gas to present itself in the lymphatics.

Three roentgenograms; 1 photograph; 5 photomicrographs; 1 table.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Barium Reduction of Intussusception in Infancy.** Edward J. Denenholz and George S. Feher. California Med. **82**: 8–12, January 1955.

This report is based on 29 consecutive infants with intussusception treated on an out-patient basis in a private office.

All infants suspected of intussusception were given a barium enema examination and, if intussusception was observed, hydrostatic reduction with barium was used as the initial treatment. In 22 of the 29 patients reduction was successfully accomplished. It was successful in all patients in whom symptoms were present for less than forty-eight hours. There were no recurrences.

Twenty-two of the 29 infants were spared anesthesia and an abdominal operation. It is emphasized, however, that all patients were observed in private practice, that they could be followed closely, and that parental cooperation could be expected.

Close cooperation between the pediatrician and radiologist was the aim. The decision to persist in attempting to reduce the intussusception was a joint one, arrived at in each case by appraisal of the entire clinical picture.

This article should be read in its entirety, for its excellent presentation of the method and the rationale of non-operative treatment. JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

**Abdominal Gas Cysts Complicated by Intestinal Obstruction.** Albert J. Kukral, J. R. Plank, and John Denst. Ann. Surg. **141**: 109–114, January 1955.

This is the report of a case of pneumatosis cystoides intestinalis involving principally the distal half of the small bowel. The patient showed also an unusual type of obstruction, consisting of multiple ligature-like strictures of the intestinal wall, due apparently to the presence of discrete, string-like fibrous scars in the submucosa.

Roentgen findings suggesting the diagnosis of pneumatosis were present in this case but were misinterpreted. These were: small bowel dilatation, suggesting partial obstruction; the appearance of reticulated, cyst-like, multilocular, translucent shadows, thickening the bowel wall; pneumoperitoneum; the "Moreau-Chilaiditi" sign (interposition of a loop of bowel between the liver and diaphragm). Although most cases are associated with other gastric or intestinal lesions, mainly peptic ulcer with pyloric stenosis, such an association was not present in this instance.

Treatment by surgical resection of the most severely constricted areas was carried out, and postoperatively cortisone was administered in the hope that further cicatrization might be prevented. These efforts brought about a clinical recovery that was surprisingly complete.

The authors point up the similarity of the findings in this case to those in regional ileitis. The presence, in the areas of narrowing, of jejunal glands resembling Brunner's glands of the pyloric region was an unusual feature. A good discussion of pathologic and diagnostic considerations is included.

Two roentgenograms; 2 photographs; 2 photomicrographs. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Sigmoidouterine Fistula Complicating Diverticulitis. Report of a Case.** M. Harlan Johnston and George M. Stubbs. Ann. Surg. **141**: 138–140, January 1955.

Sigmoid diverticulitis, which constitutes 85 per cent of all cases of diverticulitis, may be complicated by perforation with peritonitis, abscess formation, peridiverticulitis with obstruction, hemorrhage, and fistula formation. A case with fistula formation into the uterine cavity, in which a correct preoperative diagnosis was made possible by barium enema, is described by the authors.

A barium enema is credited with being the most efficient means for demonstration of fistula between two different segments of the gastrointestinal tract. However, cystograms performed with other opaque media, such as Skiodan, will occasionally succeed in demonstrating vesicosigmoidal fistula when the barium enema has failed. Sigmoidouterine fistula due to diverticulitis requires adequate clinical correlation as well as the barium enema for definite diagnosis.

The case under discussion occurred after the menopause, at which age both cancer and diverticulitis with fistula formation must be considered in the differential diagnosis. The presence of purulent discharge from the cervix probably should suggest malignant disease of the uterus as the more likely.

If infection can be controlled and obstruction prevented, treatment by primary resection is advocated.

One roentgenogram. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Estimation of Liver Function by Cholangiography.** Eric Samuel, Jonathan Gluckman, and John Barlow. Lancet **1**: 13–15, Jan. 1, 1955.

Thirty patients on whom cholangiography was performed were subjected also to routine laboratory tests of liver function. The rate of excretion and the concentration of the contrast medium, demonstrated radiographically, were correlated with the laboratory findings in an attempt to assess the value of cholangiography in estimating the function of the liver.

Following a test dose, 20 ml. of Biligrafin was injected intravenously. Fifteen minutes later radiographs were taken in the prone and prone-oblique positions. In patients with satisfactory excretion of the medium, the common bile and hepatic ducts were clearly seen. Forty minutes after injection, films were taken in the same positions, and at this stage the gallbladder usually showed some concentration of the contrast material. One or two hours after the injection, radiographs were taken with the patient prone and erect.

If the density of the medium in the common bile duct, where it lay outside the liver shadow, was equal to the soft-tissue density of the adjoining liver, then the con-

centration was regarded as good. If the shadow of the medium was less than that of the adjoining liver, and the outline of the bile ducts could still be seen, the concentration was considered to be only moderate. If no medium was seen in the biliary system throughout the examination, the concentration was judged to be poor.

Twelve patients were classed as "normal" on the basis of both the laboratory findings and the roentgen examination. Seven were considered normal radiographically but were thought to have "slight impairment" of liver function in view of a slightly elevated thymol and gamma turbidity associated with a normal albumin/globulin ratio. In each of these cases the globulin was absolutely increased, and often there was increased gamma globulin. In 3 patients in whom laboratory studies indicated "moderate impairment," the contrast medium was visualized faintly on radiographs taken at fifteen minutes. In 4 patients with "severe impairment," no excretion of medium was demonstrated radiologically. Each of 2 patients with "slight impairment" with some evidence of obstruction showed poor excretion at fifteen minutes. In 2 patients in whom laboratory data indicated both obstruction and "moderate impairment" of liver function, no excretion of Biligrafin was revealed radiographically, although a urogram showed excretion at fifteen minutes in 1 of these.

The authors conclude that a broad estimate of liver function can be made from cholangiography alone.

One table summarizing the 30 cases.

**The Use of Cholografin in the Postcholecystectomy Syndrome.** Edwin M. Cohn, Theodore L. Orloff, David M. Sklaroff, and Jacob Gershon-Cohen. Ann. Int. Med. **42:** 59-68, January 1955.

The postcholecystectomy syndrome is defined as persistence, following cholecystectomy, of symptoms originally attributed to disease of the gallbladder. It may be the result of anomalies of the biliary tract, stenosis of the common duct, neuroma of the common duct, fibrosis of the sphincter of Oddi, cholangitis, cystic duct stump, common duct stones, or biliary dyskinesia due to spasticity of the sphincter of Oddi. Functional disorders with gastrointestinal manifestations and organic disease outside of the biliary tract may also mimic gallbladder abnormalities clinically.

Cholografin, a substance which permits radiographic visualization of the biliary tree after intravenous injection, makes possible the non-surgical demonstration of common duct stones, as well as most of the other defects mentioned.

A dramatic example of physiologic changes within the common duct is presented. Morphine sulfate administered after intravenous injection of Cholografin produced biliary dyskinesia, and simultaneous dilatation of the common duct was shown roentgenographically. Later administration of nitroglycerine brought about relaxation of the sphincter of Oddi, with emptying of the medium into the duodenum and relief of pain.

Thus, it appears reasonably well established that spasticity of the sphincter of Oddi may at times be responsible for the postcholecystectomy syndrome. Cholografin is shown to be one of our most promising diagnostic tools in this puzzling and distressing symptom complex.

Five roentgenograms. DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Postcholecystectomy Oral Cholangiography.** J. Russell Twiss, Lee Gillette, Samuel L. Beranbaum, Maxwell H. Poppel, and Eilif C. Hanssen. Arch. Int. Med. **95:** 59-65, January 1955.

The results of 106 oral cholangiographic studies are presented. A double dose of Telepaque was given and hourly films were obtained beginning either five or fourteen hours later. The maximum excretion of the medium was found to occur at five hours in some cases and at fourteen in others.

In 42 studies of postcholecystectomy patients having no symptoms, the common duct was visualized in 33. It showed no significant dilatation, *i.e.*, measurement above 7 mm. Visualization was obtained in 24 of 32 patients with a clinical diagnosis of dyskinesia and two-thirds of the group showed significant dilatation of the duct.

In the entire series of 106 studies, the common duct was visualized in 74. In a number of cases there was demonstration of stones, remnants of the cystic duct or gallbladder, and of gallbladders not demonstrated by conventional oral methods. The pathological findings were confirmed by surgical exploration.

The authors attribute the success of their procedure to preliminary dehydration of the patient (twelve hours), the administration of camphorated opium tincture two hours after injection of the medium, to induce a sustained spasm of the common duct, and the taking of hourly films. Following visualization of the ducts, an effort was made to differentiate between functional and organic disease by giving an inhalation of amyl nitrite or a fat meal and obtaining a final film thirty minutes later.

It is felt that the frequency and degree of visualization with this method are comparable to those with intravenous cholangiography in most cases.

Seven roentgenograms; 2 tables.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

**Retroperitoneal Cavernous Hemangioma Associated with Hemangiomas of the Skin in a Newborn. Case Report and Brief Review of the Literature.** J. Richards Aurelius, Donald H. Peterson, and Ismail Niknejad. Minnesota Med. **38:** 32-37, January 1955.

A case of retroperitoneal cavernous hemangioma associated with similar lesions of the skin in a newborn male infant is reported. The abdomen was distended by a large oval mass which could be palpated in the right lower quadrant and flank and appeared to extend down into the right pelvis. Bilateral hydroceles were present. Two dark strawberry-colored tumors, each measuring 4 cm. in diameter, were seen, one on the upper lateral aspect of the right thigh and the other on the skin over the right patella.

A scout film of the abdomen revealed a soft-tissue mass in the right lower quadrant, which seemed to displace the normal gas-containing loops of large and small intestine to the left. A roentgenogram of the right leg showed the soft-tissue masses which were noted on physical examination, with definite calcification in the tumor over the patella. The calvarium was normal, with no evidence of metastasis. About 5 c.c. of urographic medium was injected into the subcutaneous tissues of both buttocks; the urogram on the left side was normal, but no contrast medium was demonstrable on the right. Films taken during a barium enema study, however, revealed normal urograms bilaterally.

It was then assumed that the retroperitoneal mass in the right lower quadrant was probably separate from the right kidney or at least did not involve its collecting system.

The possibility of a Wilms' tumor or sympathicoblastoma was considered. Absence of metastasis to the lungs and lack of derangement of architecture of the right kidney were against the diagnosis of Wilms' tumor. Sympathicoblastoma was thought unlikely because of the lack of any discernible metastasis in the long bones and in the skull. The possibility of a retroperitoneal cavernous hemangioma was suggested by the presence of hemangiomas of the skin on the same side of the body on which the abdominal tumor was palpated and demonstrated roentgenologically. A mass of tissue, measuring 9 × 7 cm. in its broadest dimensions and 2 cm. in thickness, was removed surgically. The pathologic diagnosis was cavernous hemangioma of the abdomen. The infant died postoperatively.

Three previously reported cases of retroperitoneal cavernous hemangioma are summarized.

Five roentgenograms; 1 photomicrograph.

**Pancreas Visualization by Right Lateral Sagittal Tomograms After Combined Retro- and Intraperitoneal Gas Insufflation.** H. Ludin. Schweiz. med. Wchnschr. **85**: 55-61, Jan. 15, 1955. (In German)

After a discussion of various methods previously used for the x-ray examination of the pancreas, the author describes a technic using sagittal body-section radiography following pneumoperitoneum combined with retroperitoneal gas insufflation. It is done with the patient fasting and the colon clean. Following the prophylactic injection of 5 c.c. of Coramine, 1,500 c.c. of oxygen is introduced into the retroperitoneal space with the patient in the knee-elbow position on the fluoroscopic table. Six hundred cubic centimeters of carbon dioxide is then injected intraperitoneally and the patient is made to assume a sitting position on the tomograph with the right side close to the film, leaning forward. A supine scout film and right lateral sagittal tomograms are obtained. This method, used on 8 patients, made it possible to distinguish the abnormal from the normal pancreas.

Following a discussion of the normal anatomy of the pancreas and its relationship to the adjacent organs, 3 cases are presented.

*Case 1:* A 62-year-old white female had a palpable, small, movable tumor in the left upper abdomen. Combined intraperitoneal and retroperitoneal air insufflation demonstrated a normal pancreas, bordered anteriorly by the bursa omentalis (containing carbon dioxide). Its posterior aspect was demarcated by the oxygen in the retroperitoneal fat tissue. X-ray examination of the stomach demonstrated a large carcinoma of the antrum. The gastric carcinoma and normal pancreas were confirmed on operation.

*Case 2:* A 76-year-old white male, complaining of icterus for three weeks, failed to show any evidence of disease on routine x-ray examination of the gastrointestinal tract. Particularly, there was no enlargement of the duodenal loop. The sagittal tomogram after combined gas insufflation revealed an enlargement of the head of the pancreas to about the size of an apple. This pancreatic tumor was well demonstrated by the oxygen in the retroperitoneal fat tissue. Operation confirmed the diagnosis.

*Case 3:* A 42-year-old white female, with a long history of gallbladder attacks with icterus, had numerous concrements in the region of the head of the pancreas as shown on a routine abdominal film. Cholecystography demonstrated a large gallbladder, with evidence of dyskinesia. The sagittal tomograms after combined pneumoperitoneum and retropneumoperitoneum showed no carbon dioxide in the bursa omentalis, probably due to peripancreatitis with adhesions occluding the entrance of the bursa omentalis. This confirmed the clinical diagnosis of chronic pancreatitis with pancreatic insufficiency.

On the basis of his limited experience the author believes that combined retroperitoneal and intraperitoneal gas insufflation is not dangerous. He considers sagittal stratigraphy of the pancreas following insufflation an important diagnostic aid in the recognition of lesions involving the head and the tail of the pancreas and other obscure upper abdominal lesions.

Seven roentgenograms; 7 drawings; 2 photographs.

HERBERT POLLACK, M.D.
Chicago, Ill.

## THE DIAPHRAGM; HERNIA

**Surgical Correction of Eventration of Diaphragm in Patient with Arthrogryposis. Observations on Cardiac Manifestations of Traction on Diaphragm.** Philip Crastnopol, Lew A. Hochberg, and Irving G. Kroop. Arch. Surg. **70**: 114–119, January 1955.

Arthrogryposis, or amytonia congenita, frequently is accompanied by absence of the serratus anterior and latissimus dorsi muscles. These findings, along with eventration of the right diaphragm, were encountered in a year-old girl with arthrogryposis. She also presented a rounded density in the right cardiophrenic angle which created a problem in differential diagnosis. This ultimately proved to be due to an abnormally elevated liver. Fluoroscopy and pneumoperitoneum with upright and decubitus radiographs suggested the diagnosis preoperatively.

Surgical repair of the eventration was accomplished by plicating the lax portion of the diaphragm with a series of reefing sutures. Biopsy indicated that the eventration was coincidental and unrelated to the arthrogryposis.

Five roentgenograms; 4 electrocardiograms; 1 photograph.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Hernia Through the Esophageal Hiatus Simulating Coronary Pain. Report of Fifty Cases.** Joe Holoubek, W. H. Carroll, Richard B. Langford, and G. M. Riley. South. M. J. **47**: 1043-1048, November 1954.

During a three-year period the authors saw 50 cases of hernia through the esophageal hiatus in which the symptoms were strongly suggestive of coronary disease. The patients ranged in age from thirty-one to seventy-three, averaging fifty-one. Eighteen were women. Only 8 were of asthenic habitus; 14 were hypersthenic and obese and the remainder sthenic. In 24 cases heart disease had been diagnosed previously.

Forty-eight patients described the pain as substernal, usually in the lower left substernal region. The pain was usually acute in onset, occasionally vise-like, but usually "deep and boring." It radiated to the back in 5 patients, to the left shoulder in 14, to the left arm

in 16, to the right arm in 2, and to the apex of the heart in 2. Twenty-nine patients reported pain after eating a heavy meal, 6 with mild exercise after eating, 21 on reclining, and 10 when they sat in a cramped position or wore a tight abdominal binder.

All patients had a careful physical examination and laboratory studies. Electrocardiograms were taken repeatedly.

Careful fluoroscopic studies with the patient in the Trendelenburg position during the Valsalva maneuver, after a barium swallow, is essential, and this procedure was carried out in all of the authors' patients. Two-thirds of the patients had had previous gastrointestinal studies and the hernia was not found because the patient was examined in the upright position. In 2 patients previous fluoroscopic studies had failed to reveal the defect.

Three patients had surgical repair of the hiatal hernia. A careful explanation of the cause of the pain and reassurance that the heart is not responsible are usually satisfactory, however. Weight loss, antispasmodics, sleeping in a semi-sitting position, small meals, and avoidance of abdominal binders are also necessary in medical management.

Twelve illustrative cases are reported in detail.

Five roentgenograms; 2 tables.

**Diagnosis of Hiatus Hernia on Plain Roentgenograms of the Thorax and Abdomen.** Francis J. O'Connor and Max Ritvo. J.A.M.A. **157:** 113–117, Jan. 8, 1955.

The diagnosis of hiatus hernia can often be made or suspected in the course of x-ray examinations of the chest, ribs, spine, gallbladder, urinary tract, and abdomen without the aid of radiopaque material. Hiatus hernias are of four types: (1) short esophagus, (2) the sliding type through the esophageal hiatus, (3) paraesophageal hernia, which may produce the so-called upside-down stomach, (4) a combination of short esophagus and sliding hiatus hernia.

In the various film studies mentioned, a soft-tissue density with or without associated gas and of varying size may be seen in the lower mediastinum in close relation to the heart and the diaphragm. A large retrocardiac density or air-fluid level extending the entire width of the heart shadow occurs in the paraesophageal type of hiatus hernia. With the patient upright, the presence of two adjacent paravertebral air-fluid levels in the sagittal projection and overlapping air-fluid levels in the lateral projection indicate an "upside-down" stomach with two loculi. In the lateral recumbent projection, the hernia may be manifested by the presence of bilocular retrocardiac shadows with associated central radiance in the region adjacent to the diaphragm. The smaller posterior shadow usually represents the cardia and the larger the media of the stomach.

In large hiatus hernias, especially of the paraesophageal type, the splenic flexure of the colon frequently is herniated also.

Areas of soft-tissue density without gas which may resemble hiatus hernia may be found with (1) paravertebral abscess, (2) aortic aneurysm, (3) uncoiled aorta, (4) enlarged left auricle of the heart, (5) benign neoplasm of the esophagus, such as leiomyoma or cyst, (6) mediastinal collection of fluid, (7) enlarged lymph nodes, (8) bronchogenic neoplasm, (9) malignant lymphoma, (10) retroperitoneal or gastrointestinal neoplasm, (11) tumor of the sympathetic or spinal nerve ganglia, (12) pneumonitis, bronchiectasis, or pulmonary infarction, (13) arteriovenous fistula, (14) infrapulmonary effusion, (15) intralobar sequestration of the lung.

Soft-tissue densities associated with gas that may resemble hiatus hernia are: (1) epiphrenal diverticulum, (2) cardiospasm, (3) lung abscess, (4) displacement of the stomach into the chest after surgery, (5) bronchopleural fistula, (6) gastropleurobronchial fistula with carcinoma of the gastric cardia, (7) colonopleurobronchial fistula associated with peritonitis, (8) emphysematous blebs, (9) cysts, (10) hydropneumopericardium.

The differential diagnosis of eventration of the diaphragm is discussed.

Five roentgenograms. WILLIAM SNOW, M.D.
Shreveport, La.

## THE MUSCULOSKELETAL SYSTEM

**Osteosclerosis Associated with Chronic Renal Failure.** T. Crawford, C. E. Dent, P. Lucas, N. H. Martin, and J. R. Nassim. Lancet **2:** 981–988, Nov. 13, 1954.

The authors present 3 cases of chronic renal failure with osteosclerosis, *i. e.*, a great increase in the formation of normal bone, detected roentgenologically and proved histologically. The osteosclerosis in these cases was not of similar distribution and severity. In Case I, in a man of forty-two, it was very severe and widespread and affected equally all the bones of the skeleton. In Case II, in a girl of fourteen, only the vertebrae showed marked sclerosis, and this was seen to develop during the four years of her follow-up. In Case III, in a man of twenty-six, the vertebrae were involved, but there was also well marked generalized osteitis fibrosa. On clinical grounds the cases could hardly be less alike, both in age of incidence and possibly also in etiology. From the physiological point of view there was again no special feature which might help to account for the osteosclerosis. One patient had marked enlargement of the parathyroid glands and showed typical osteitis fibrosa in addition to the osteosclerosis. In the other 2 there were no signs of hyperparathyroidism.

Cases II and III showed disproportionate and excessive length of the limbs in relation to the trunk. This is a curious finding in chronic renal failure, in which proportional dwarfism is considered characteristic. The authors suggest that this disproportionate limb length is further possible, but rare, evidence of chronic renal failure occurring before growth of the long bones ceases.

It is felt that osteosclerosis is much more common in renal failure than the literature would lead one to believe. A review of roentgenograms in other cases indicated failure to detect it when it was clearly present in a mild degree. It seems to be more often demonstrable in the vertebral bodies than anywhere else, and the authors wonder if it may also occur in the growing ends of long bones. The resemblance of the radiologic picture to that in some cases of the alleged *formes frustes* of marble-bone disease gives food for thought.

Nine roentgenograms; 5 photomicrographs.

**Diagnostic Significance of Pulmonary Hypertrophic Osteoarthropathy.** Alfred Vogl, Serge Blumenfeld, and Leonard B. Gutner. Am. J. Med. **18:** 51–65, January 1955.

Seven cases of pulmonary hypertrophic osteoarthrop-

athy accompanying serious intrathoracic disease are presented by the authors.

Since symptoms of pulmonary hypertrophic osteoarthropathy may precede clinical recognition of lung tumors by many months, and since the osteoarthropathy of itself may cause invalidism and suffering simulating rheumatoid arthritis, the recognition of this condition becomes important for diagnostic and therapeutic reasons.

Of the authors' 7 patients, 5 had proved lung cancer. In 5 patients symptoms referable to the extremities were the presenting complaints on admission. There was rapid regression of symptoms referable to the osteoarthropathy after successful treatment of the intrathoracic condition, and there was no recurrence of the symptoms in spite of subsequent metastases in 2 cases.

The case reports illustrate the clinical features of pulmonary hypertrophic osteoarthropathy: (1) bone pain, (2) stiffness of fingers, (3) muscular weakness, (4) non-pitting edema with increase in the diameter of the affected extremity, (5) redness and warmth of the overlying skin, (6) tenderness to pressure over affected bones and pain on passive motion, (7) progressive clubbing of fingers and toes.

The radiologic findings consisted of fairly symmetrical, coarse or lamellar subperiosteal bone formation along the diaphyses of the long bones, including metatarsals, metacarpals, and proximal phalanges.

Although the etiology of this condition is still obscure, the authors, along with others, feel that the abnormally increased peripheral blood flow plays an important role. This may be dependent upon some pathological intrathoracic reflex which is promptly abolished by surgical removal of the lung tumor.

Nineteen roentgenograms; 4 photographs.

ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

**Rare Case of the Bony Form of Hodgkin's Lymphogranuloma.** O. Soyka, E. Šilinkova-Málková, and O. Blazek. Acta radiol. & cancerol. bohemoslov. **8**: 173–177, July 1954. (In Czechoslovakian)

A case is reported in which the striking feature, to quote the author, was an "almost incredible divergence between the skeletal changes and the excellent clinical condition of the patient"—a young woman in whom histologic evidence of bone involvement by typical Hodgkin's disease was obtained over a period of eleven years. It is uncertain whether the lymphogranulomatous lesions originated in the peristernal lymph nodes or in the sternum itself, but the disease was largely confined to the osseous tissue. Only occasionally, inconspicuous node manifestations were observed which, as a rule, rapidly disappeared in the course of x-ray therapy. The bone involvement, on the other hand, progressed slowly, extending in band-like form around the upper thoracic cavity. Even when osteoplastic repair occurred, the regenerative process was temporary, sooner or later giving place to osteolysis and bone destruction. At one time, a compression fracture of the first thoracic vertebra ensued. No metastasis or general distribution of the disease could be ascertained after the long period of observation, and the patient continued to feel well.

Eight roentgenograms.

E. A. SCHMIDT, M.D.
Hilo, Hawaii

**Ochronosis: Report of Two Cases.** Hugh P. Smith and Hugh P. Smith, Jr. Ann. Int. Med. **42**: 171–178, January 1955.

Ochronosis is a rare metabolic disorder in which the basic defect is apparently an anomaly of metabolism of certain amino acids. Normally, these break down to acetone, with homogentisic acid as an intermediary product. In patients who cannot break it down, homogentisic acid is excreted in the urine (alkaptonuria). If alkaptonuria lasts long enough, ochronosis usually occurs, with pigment deposits in certain relatively avascular areas, as the articular cartilages and the sclerae.

Two cases are described in brothers, both of whom showed osteoarthritic changes of the spine, prostatic calculi, and hypertensive cardiovascular disease. The deposition of homogentisic acid apparently causes premature degeneration of the articular cartilage so that it becomes highly friable and easily cracked. Detached fragments may form joint mice. Pigment also may be deposited in tendons, ligaments, intervertebral disks, atheromatous plaques, and even in muscle.

A rather distinctive calcification of the spinal intervertebral cartilages occurs, demonstrable radiologically as a rather marked narrowing of the interspace along with an elliptical, wafer-like appearance of the disk in the lateral view. In the peripheral joints degenerative changes are seen most frequently in the shoulder, a significant finding, since ordinary osteoarthritis usually does not affect the shoulder joints. Occasionally, also, there may be punctate calcifications in the periarticular tissues of the peripheral joints, and sometimes punched-out lesions similar to those of gout. Calculi have been noted in many cases in the prostate and bladder. The ocular pigmentation, usually occurring on the medial or lateral aspect of the sclera, is of great diagnostic aid.

Relatively simple laboratory procedures permit a definite diagnosis. Therapy, aside from general symptomatic measures for the arthritis and associated discomfort, have not been successful.

Three roentgenograms.

DON E. MATTHIESEN, M.D.
Phoenix, Ariz.

**Sudeck's Syndrome After Fractures.** G. Bierling and D. Reisch. Fortschr. a. d. Geb. d. Röntgenstrahlen **82**: 1–14, January 1955. (In German)

Sudeck's bone atrophy appears to be of more frequent occurrence after fractures than formerly. In a period of three years it was found in 587 (18.5 per cent) of 3,170 fracture cases. The lower extremities were affected twice as often as the upper. There was also a predominance in the younger and older age groups and in the climacterium.

Roentgenologically, the authors differentiate between the spotty type, a band form (subchondral and metaphyseal), diffuse and mixed forms of osteoporosis. The diffuse form is seen principally in the first decade of life, but also in adolescence up to the age of twenty. The band form involves chiefly the ankles and wrists. A moth-eaten appearance is seen in the region of the hips, and a lacunar decalcification has been observed at the anterior tibial ridge, for the most part when skeletal traction is applied with a Kirschner wire.

Treatment in the series reported consisted in roentgen therapy combined with injection of a hormone preparation "Notandron" (methylandrosteniol). At times

rapid regression of an advanced Sudeck atrophy occurred even without special therapy.

Eight roentgenograms; 3 tables; 3 drawings.

ERNEST KRAFT, M.D.
Newington, Conn.

**Osteo-arthritis Deformans of the Luschka Joints.** A. J. E. Cave, J. D. Griffiths, and M. M. Whiteley. Lancet **1**: 176–179, Jan. 22, 1955.

A significant proportion of cases of cervicobrachial neuritis have been ascribed to herniation or protrusion of the cervical intervertebral disks, in particular to an alleged lateral (or dorsilateral) protrusion of disk tissue into the intervertebral foramen. The authors direct attention to a more obvious and ubiquitous cause, namely, a deforming osteoarthritis of the joints of Luschka (neurocentral joints), a disease which constitutes in their opinion the commonest mechanical cause of cervical nerve root irritation. They describe a study based upon the examination of the bony changes in a series of 50 macerated cervical spinal columns of known age and sex, upon the detailed dissection of a further 10 adult cervical spines with particular reference to articular and disk changes, and upon the clinical and radiological examination of unselected patients at St. Bartholomew's Hospital (London), who complained of symptoms or signs of cervicobrachial neuritis.

Osteoarthritis of the Luschka joints is of insidious onset, declaring itself most often in the fifth and sixth decades of life, but beginning not infrequently in the fourth. As with osteoarthritis elsewhere, it is progressive: an increasing number of Luschka joints become involved in the later decades and the individual distortion of each joint becomes more pronounced. Trauma is not a cause, and characteristically the cervical zygapophyseal joints are normal. The clinical picture is a cervicobrachial neuritis of "high," "low," or "mixed" variety, involving the roots of the cervical or the brachial plexus or of both. Constant pain is always a symptom; it commonly radiates down the radial border of the arm and forearm and it is very often associated with a similar kind of pain in the neck.

In the authors' patients lateral oblique films of the cervical spine showed some encroachment upon the intervertebral foramina by osteophytes from the Luschka joints. Usually a number of foramina were narrowed, generally bilaterally; only once was a single foramen affected. The precise degree of narrowing was not related directly to the severity of the disease, for symptoms result, not from compression by osteophytes, but from excessive angulation (and consequent irritation) of the spinal nerve by the osteophyte mass where the nerve enters the medial end of the intervertebral foramen. Not every neck with an x-ray picture of Luschka-joint arthritis necessarily gives rise to symptoms. On the other hand, in every patient in the authors' series (all with cervicobrachial neuritis) radiologic evidence was invariably present. Radiography therefore can confirm suspected Luschka-joint lesions, but it gives no guide to the severity of symptoms. Zygapophyseal osteoarthritis was also present in 1 case. In a third of the clinical cases the cervical disks were found radiologically to have shrunk, as expected, with age; in the remainder the disks were unchanged in depth. The disks most often affected were 5–6 and 6–7, *i. e.*, the disks situated where cervical movement is greatest. Anterior lipping of the cervical vertebral bodies and ossification of the anterior common ligament, seen in a few cases, are unrelated phenomena due to age.

Neurocentral apophysectomy of the affected joints is the only means of permanent cure, but how practicable such an operation may prove when a number of Luschka joints are involved the authors do not feel competent to say. Palliative therapy, apart from analgesics, includes a long course of short-wave diathermy and immobilization of the cervical spine. Neck traction or manipulation is valueless and is likely to aggravate symptoms.

Two roentgenograms; 6 photographs.

**Subluxation and Deformation of the Cervical Apophyseal Joints: A Contribution to the Aetiology of Headache.** Ákos Kovács. Acta radiol. **43**: 1–16, January 1955.

In this paper, the author deals with the subluxation of the small joints of the upper cervical spine which results in constriction or circulatory disturbances in the vertebral artery and impaired function of the sympathetic vertebral plexus. The artery and nerve are rather frequently affected by the deformities of adjacent bone borders. The nerve roots and vertebral artery are in close relationship. Bilateral or unilateral headaches result.

Subluxation may be due to chondrosis or trauma. In some cases, the site of impaction is due to an osteophyte. Headache radiating from the top of the skull and the nuchal region as well as the upper cervical sympathetic syndrome is more frequently produced by pressure exerted on the vertebral artery and nerve by the superior articular process than any other condition.

Anteflexion—traction of the head—typically relieves the headaches.

Seventeen figures.

LAWRENCE A. PILLA, M.D.
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**Osteochondroma of the Lumbar Spine. Report of a Case.** Husameddin Gokay and Paul C. Bucy. J. Neurosurg. **12**: 72–78, January 1955.

Although osteochondroma is a common tumor, its occurrence in the spine is unusual. The authors report a case with involvement of the second through the fifth lumbar vertebra, in a young woman with multiple osteochondromata elsewhere in the skeleton and with a familial history of such lesions.

The spinal tumor grew laterally but extended also into the spinal canal and compressed the cauda equina. This resulted in neurological changes with some atrophy of the lower extremities. The tumor was removed in a two-stage operation, and almost complete recovery ensued, in spite of considerable damage to the cauda equina. Four years after surgery there was no evidence of recurrence even though removal had not been complete.

Four roentgenograms.

G. J. WOOLHANDLER, M.D.
Shreveport, La.

**Lumbar Disk Syndrome Caused by Malignant Tumors of Bone.** Richard T. Odell and J. Albert Key. J. A. M. A. **157**: 213–216, Jan. 15, 1955.

In a period of twelve years, the authors saw 19 patients with malignant tumors involving the bones of the lumbosacral area. Ten had symptoms of an intervertebral disk lesion and were treated conservatively; 9 were operated on for an intervertebral disk lesion. The tumors, as finally diagnosed, included chondro-

sarcoma, fibrosarcoma, osteogenic sarcoma, giant-cell tumor, solitary plasmacytoma and metastases from the prostate, cervix, anus, kidney, vagina, thyroid, and lung. The incidence of skeletal metastasis in patients dying of cancer is reported as anywhere from 12 to 27 per cent, the highest rate probably being the most accurate. The absence of abnormalities visible on roentgenograms does not rule out the possibility of a lesion in the bone.

In this series, operation resulted in relief of pain in 4 of the 9 patients who were operated on for a disk lesion when a tumor was present and in 4 of the other 10 in whom the operation was done as a palliative measure.

Two roentgenograms; 1 photomicrograph; 1 table.

SHOZO IBA, M.D.
Huntington Park, Calif.

**Pantopaque Pulmonary Embolism. A Complication of Myelography.** Leonard B. Ginsburg and Alan B. Skorneck. Am. J. Roentgenol. **73:** 27–31, January 1955.

Injection of Pantopaque into a vein of the vertebral system with resultant pulmonary embolism is a rare complication of lumbar myelography. During the course of the latter procedure in a man of fifty-four, 9 c.c. of Pantopaque was inadvertently injected within the body of the third lumbar vertebra. Because the movement of the inital 3 c.c. of oil within the subarachnoid space seemed sluggish, the needle was advanced slightly. At this time, upon removal of the stylet, fresh blood was expressed. The needle was withdrawn slightly, and blood-tinged spinal fluid was seen. Believing that he was within the subarachnoid space, the operator then injected an additional 9 c.c. of the Pantopaque. However, fluoroscopic examination after this procedure demonstrated only about 2 c.c. in the subarachnoid space. Films of the spine were made, and these showed the tip of the needle within the body of the third lumbar vertebra and oil droplets in the basivertebral veins. The patient at this time experienced no unusual sensations.

On the evening of the procedure a severe shaking chill occurred and the temperature rose to 102.4° F. The next morning a chest roentgenogram revealed numerous small, nodular, fuzzy infiltrative densities in both lower lung fields, more on the left than on the right. These were not present on a film made before the procedure and were felt to represent focal areas of edema and hyperemia due to plugging of capillaries by oil droplets. The next day the patient experienced one episode of coughing and brought up a scant amount of blood-tinged sputum. A repeat film disclosed complete disappearance of the nodular shadows, and the temperature reverted to normal in two days.

This is the first case to be reported in which there was direct injection of an opaque medium into a vein of the vertebral system (basivertebral vein) during myelography. Because of the higher pressure in the subarachnoid space as compared to the venous network, it is also possible to obtain an indirect injection of medium into the latter if a vessel is nicked or torn by the needle during myelography. Three such cases have been reported. This is also the second published case with pulmonary roentgenographic evidence of embolism following such an accident.

The authors believe that in the presence of a bloody spinal tap it would be wise to postpone myelographic examination for several days to avoid the possibility of direct or indirect entrance of the medium into the venous system.

Five roentgenograms; 2 drawings.

RICHARD G. LESTER, M.D.
University of Minnesota

**Protrusion of the Acetabulum.** Franco Mainoldi. Radiol. med. (Milan) **41:** 17–25, January 1955. (In Italian)

Eight cases of primary acetabular protrusion of significant degree are presented. Aside from the medial disposition of the acetabula, one finds acetabular sclerosis and at times an osseous spine on the anatomical neck of the femur, usually on the cephalic border but at times on the caudal. The problem of pathogenesis is difficult. In some cases there is a traumatic factor, but probably with an underlying constitutional basis. Osteoarthrosis is secondary.

The cases reported by the author do not include the so-called secondary protrusions, associated with acute inflammatory processes, osteomalacia, etc.

Eight roentgenograms.

CHRISTIAN V. CIMMINO, M.D.
Fredericksburg, Va.

**Congenital Ankylosis of the Elbow.** Richard Y. Card and Jerome Strachman. J. Pediat. **46:** 81–85, January 1955.

What is believed to be the thirty-fifth case of congenital ankylosis of the elbow is reported. This is also said to be the tenth case of bilateral elbow ankylosis not associated with other anomalies. Both elbows were ankylosed, forming an angle of 90 degrees on the left and 95 degrees on the right. A roentgenographic study of the entire skeleton was made at six weeks of age. With the exception of the elbows, all of the bones and joints were found to be normally developed. The bone age of the wrists and feet was advanced, corresponding to six months. In place of the normal humero-ulnar articulation, the proximal end of the radius formed a pseudarthrosis with a shallow cup-like depression in the anterolateral portion of the distal end of the humerus. The opposing ends of the humerus and radius were abnormally widened, the radius being larger than the ulna. Roentgenograms obtained at the age of six months showed advancing synostosis of the elbows.

Congenital ankylosis of the elbows may be encountered in one of two forms: (1) as an isolated deformity and (2) in association with other anomalies. In the latter group of 25 reported cases, the more common associated anomalies were absence of one or more bony structures of the hands; other synostoses of carpals, metacarpals, and phalanges; absence of the ulna or of the opposite upper extremity; absence of one or both patellas; and shoulder girdle anomalies. All of the patients in whom the anomaly existed in isolated form showed bilateral involvement. In the other group there were 18 cases of unilateral involvement.

Five roentgenograms.

HOWARD L. STEINBACH, M.D.
University of California, S. F.

**Acute Calcium Deposits in the Hand.** Robert E. Carroll, William Sinton, and Alexander Garcia. J.A.M.A. **157:** 422–426, Jan. 28, 1955.

One hundred consecutive cases of acute calcium deposits in the hand were studied. The patients ranged in age from thirteen to eighty-one years, with an aver-

age of forty-five years. The symptoms consisted of acute pain, swelling, redness, and limitation of function. Roentgenograms afforded a correct diagnosis in 73 of the cases; in 20 they were thought to reveal no abnormalities; 5 were misinterpreted as showing chip fracture or an accessory ossicle, and in 2 the nature of the abnormality was indeterminate. The importance of the proper projection or projections is emphasized. True anteroposterior and lateral views, for example, may fail to demonstrate a calcium deposit in the flexor carpi ulnaris or digital flexor.

The pathogenesis of these deposits is obscure. Stress or strain may cause a slight tear in the tendon or ligament, resulting in deposition of calcium phosphate and calcium oxalate. The magnitude of the stress is not necessarily great. In several days there is an acute inflammatory process. The signs and symptoms will subside in one to fourteen days with conservative treatment.

Eight roentgenograms; 1 diagram.

SHOZO IBA, M.D.
Huntington Park, Calif.

**Marble Bone Disease with Brachydactylia.** L. Takáts and N. Henye. Fortsch. a. d. Geb. d. Röntgenstrahlen **82:** 43–47, January 1955. (In German)

A case of osteopetrosis with associated brachydactylia is reported in a male of 21 years. The disorders were discovered following a mild trauma which had resulted in a pathologic fracture of the left tibial midshaft. There was no hereditary or familial background. The patient was small and had rachitis-like deformities in early childhood. The tips of the fingers were short, and atrophic bone changes were noted in the terminal phalanges of fingers and toes.

Both osteopetrosis and brachydactylia are conditions with an hereditary background and could occur simultaneously as separate entities. In an identical case reported by Seigman and Kilby (Am. J. Roentgenol. **63:** 865, 1950) the two findings were considered merely coincidental. On the other hand, the authors believe that the brachydactylia in their case is part of a syndrome, with osteopetrosis as an associated phenomenon.

Seven roentgenograms.

ERNEST KRAFT, M.D.
Newington, Conn.

**Contribution to the Roentgen Diagnosis of Primary Diaphyseal Tuberculosis of the Long Tubular Bones.** A. Heidenblut. Fortschr. a. d. Geb. d. Röntgenstrahlen **82:** 34–43, January 1955. (In German)

Formerly osseous tuberculosis was reported predominantly in early life. In recent years, however, the disease has been found with increasing frequency in adults. The author reports two interesting cases. In the first case, in a boy of seventeen, the tibia was involved throughout its distal two-thirds. In the second case, in a fifty-one-year-old woman, a localized abscess cavity was found in the tibial mid-shaft.

Radiographic findings are not characteristic, and a correct diagnosis on the basis of the roentgen film is rarely possible. Osseous tuberculosis has to be differentiated from pyogenic and syphilitic osteomyelitis, ossifying periostitis, Brodie's abscess, reticulum-cell sarcoma, and especially from Ewing's sarcoma. The size of sequestra is of no significance in the differential diagnosis.

Eight roentgenograms.

ERNEST KRAFT, M.D.
Newington, Conn.

**Bone Changes in Trophic Disorders of the Leg.** A. Jakob. Fortschr. a. d. Geb. d. Röntgenstrahlen **82:** 28–34, January 1955. (In German)

Four cases are reported in which trophic disturbances of the skin and subcutaneous tissues were accompanied by periosteal proliferation in the shaft of the tibia and especially of the fibula. The bone lesions are similar to those of syphilitic periostitis and have no connection with the disease of the overlying skin, including ulcers, varices, edema, elephantiasis, and atrophic changes. In 2 additional cases marked periosteal calcification and proliferation with spur formations were noted in the os calcis, simulating sclerotic bone.

In the region of the periosteal reaction there were no ulcers or inflammation so that osteomyelitis and periostitis due to contact with an adjacent pyogenic process appeared improbable. Arteriographic studies in one case revealed arteriosclerotic changes of regional small arteries. Biopsy in another case showed reactive bone changes. In the author's opinion the changes can be explained on the basis of diminished arterial blood supply and retarded circulation.

Nine roentgenograms; 2 photomicrographs.

ERNEST KRAFT, M.D.
Newington, Conn.

**Chronic Coccidioidal Synovitis of the Knee Joint.** Federico Sotelo-Ortiz. J. Bone & Joint Surg. **37-A:** 49–56, January 1955.

Coccidioidomycosis usually involves the lungs primarily. Dissemination, if it occurs, usually takes place within the first few weeks or months after infection. Bone and joint lesions are found only in the disseminated form of the disease.

Clinically and pathologically coccidioidomycosis simulates tuberculosis. The roentgen appearance of bone lesions varies with the stage of the disease. In the acute phase, they are primarily destructive, with little bone reaction or periostitis. Periostitis, if present, however, is of some diagnostic value, since it is seldom seen in tuberculosis and is less extensive than in chronic pyogenic osteomyelitis. As healing occurs, bony sclerosis becomes apparent, but this is never as marked as in pyogenic osteomyelitis. Joint involvement occurs by direct extension through bone and articular cartilage from adjacent lesions.

The author presents 2 case reports illustrating the occurrence of chronic coccidioidal synovitis of the knee joint. In both instances there was evidence of synovial thickening on roentgenograms of the knee, but in only 1 was there evidence of lytic bone change. Diagnosis in both was made by exploratory arthrotomy.

As a result of wartime exposure and rapid modern transportation it is probable that coccidioidomycosis will be seen more frequently in areas where it is not endemic and not suspected.

Five roentgenograms; 3 photomicrographs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

**Contribution to the Analysis of Knee-Joint Roentgenograms.** G. Teichert. Röntgenblätter **8:** 4–8, January 1955. (In German)

Even though two perpendicular views must always be obtained, differentiation of the medial from the external femoral condyle on the lateral projection of the knee joint may be of help in cases of trauma and in such conditions as osteochondritis dissecans. The patella

connects with both femoral condyles. The articulation between the patella and the lateral condyle is always longer than the articulation between the patella and medial condyle. This difference in length can be readily identified on the lateral film, and the appearance will not be altered by a vertical deviation of the beam, regardless of the side of the joint placed on the cassette.

Nine roentgenograms. E. R. N. GRIGG, M.D.
Cook County Hospital, Chicago

**Rigid Valgus Foot Due to Talocalcaneal Bridge.** R. I. Harris. J. Bone & Joint Surg. **37-A:** 169–182, January 1955.

Most if not all cases of rigid valgus foot ("rigid flatfoot," "peroneal spastic flatfoot") unrelated to arthritic disease are due to congenital fusions of the tarsal bones. Two such anomalies have been recognized: the calcaneonavicular bar and the talocalcaneal bridge. The latter is the subject of this report.

Two elements are notable in the clinical picture, *i.e.*, varying degrees of deformity within rather wide limits and loss of movement at the subtalar joint. Rigid valgus foot due to talocalcaneal bridge (and other anomalies of bone structure) probably exists from birth, though a significant degree of foot discomfort usually does not appear until adolescence or adult life. Trauma is often the final factor which gives rise to symptoms.

An x-ray beam, projected through a normal foot from behind, downward and forward, at an angle of 45 degrees or slightly less, will pass through the plane of the joint between the sustentaculum and the neck of the talus, clearly revealing this joint. When a talocalcaneal bridge is present, the shadow of its mass obscures the joint. In addition, fixation of the talus and calcaneus interferes with motion in the subtalar-midtarsal set of joints, which results in osteoarthritic lipping most conspicuous at the superior margin of the head of the talus. The lateral view shows narrowing of the subtalar joint space and absence of a clear picture of the joint between the sustentaculum tali and the neck of the talus.

Incomplete development of the talocalcaneal bridge may also give rise to rigid valgus foot but is not capable of direct demonstration on roentgenograms. Films, however, may still demonstrate the secondary changes due to anchoring of movement in the subtalar joint. Diagnosis is made from the history, clinical findings, and operative observations.

Surgical treatment of rigid valgus foot should be limited to the relief of disabling pain and the correction of severe deformity. It should consist of subtalar fusion supplemented by talonavicular fusion when necessary.

Another type of fusion, seen by the author after completion of his paper, is described in an addendum. This consists of a fusion of the posterior end of the talus to the calcaneus, apparently by fusion of an os trigonum to both bones.

Twenty roentgenograms; 6 drawings; 4 photographs.
JOHN F. RIESSER, M.D.
Springfield, Ohio

**The Mechanism of Total Dislocation of the Talus.** Baldo Leitner. J. Bone & Joint Surg. **37-A:** 89–95, January 1955.

Total dislocation of the talus can result from either maximum inversion (supination) or eversion (pronation) of the foot. Accordingly the talus may be dislocated laterally (supination) or medially (pronation). This defect has been studied by the author in 42 of his own cases and a review of published reports.

Clinical and roentgen studies indicate that total dislocation of the talus represents the end-result of maximum supination or pronation of the foot, according to the following scheme:

I. Supinatory force
   (*a*) First degree: medial subtalar dislocation.
   (*b*) Second degree: medial subtalar dislocation with supination-subluxation of the talus.
   (*c*) Third degree: total lateral dislocation of the talus.
II. Pronatory force
   (*a*) First degree: lateral subtalar dislocation.
   (*b*) Second degree: lateral subtalar dislocation with supination-subluxation of the talus.
   (*c*) Third degree: total medial dislocation of the talus.

Pronation subluxation of the talus is never found. The talus must rotate as in supination before it can glide out of its position medially, since the medial malleolus and calcaneus act as obstacles when the talus is forced to luxate medially with the foot in pronation.

Fifteen roentgenograms; 6 drawings.
JOHN F. RIESSER, M.D.
Springfield, Ohio

## GYNECOLOGY AND OBSTETRICS

**Neglected Roentgenography of Breast Disease.** Jacob Gershon-Cohen, Helen Ingleby, and Mortimer B. Hermel. J.A.M.A. **157:** 325–326, Jan. 22, 1955.

Breast roentgenography in the authors' experience is more accurate in differentiating benign from malignant lesions than clinical examination. Of 102 consecutive carcinomas, 83 per cent were diagnosed correctly by roentgenography as compared to 54 per cent by clinical methods. Of 316 benign tumors, 91 per cent were correctly diagnosed radiologically as compared to 71 per cent by clinical studies.

Periodic roentgenographic studies of normal breasts are advised for detection of early carcinoma. This method would seem more effective than the present method of accidental discovery, usually by the patient. In many cases the effect of non-surgical therapeutic measures can be observed by serial x-ray examinations. [For the technic of examination and the roentgen features of benign and malignant lesions, see Gershon-Cohen and Ingleby: Radiology **60:** 68, 1953.]

Four illustrations, including 2 roentgenograms.
D. D. ROSENFELD, M.D.
Oakland, Calif.

**Ovarian Radiation During Hysterosalpingography.** E. Barnett and D. K. Bewley. J. Fac. Radiologists **6:** 186–188, January 1955.

A study of the irradiation received by the ovaries during hysterosalpingography was made, with particular reference to the use of fluoroscopy during the injection of the contrast medium as opposed to a purely radiographic technic. At the Hammersmith Hospital (London), where the investigation was undertaken, the screening technic is employed. Factors are as follows: *Screening:* 82 kv, 3 ma; maximum aperture 6 cm. square (as measured on the screen); no filter; focus-table-top distance 53 cm. *Radiography:* Anteroposterior view, 80 kv; 75 ma. Lateral view, 85 kv, 150 ma. No filter; over-couch tube, with focus-table-top

distance 82 cm.; standard films and screens with Potter-Bucky diaphragm. The dose of radiation delivered by this technic was measured in a tissue-equivalent wax phantom, 16 cm. deep, with a Bakelite-graphite ionization chamber connected to a D.C. amplifier. The chamber was placed in the phantom at various depths and distances from the mid-line, and the dosage received in each position was calculated both during screening and radiography. The total screening time in a series of 20 unselected patients was found to average 1 min. 23 sec. The average screening time during which the left ovary was being directly irradiated was 23 sec. It was assumed that the direct irradiation to one ovary would be equal that received by the other. In the majority of cases, only two anteroposterior roentgenograms are taken. In the series of 20 patients studied for these calculations, a lateral film was utilized on only three occasions.

The average dose of radiation received by one ovary, during the examination involving screening for one and one-quarter minutes and the taking of two anteroposterior films, was 1.7 r (3.2 r when one lateral film was added). The maximum dose received was estimated to be 3.6 r for a patient whose examination required the taking of four films.

The authors therefore conclude that, with the screening technic described, no additional radiation hazard is introduced into the examination of hysterosalpingography and more information is obtained than by radiography alone.

**Roentgenographic Diagnosis of Genital Tuberculosis in the Female and Roentgenographic Effects of Antibiotic Therapy.** Kristina Ekengren. Acta radiol., Supplement 123, 1955.

The roentgenographic findings in 117 proved cases of female genital tuberculosis which were examined by hysterosalpingography at the Karolinska Sjukhuset, Stockholm, are described. They were compared to observations in 150 non-tuberculous cases.

A water-soluble penicillin-fortified solution, made viscid by the addition of dextran, was used. After a preliminary scout film, the material was instilled under fluoroscopic control without a manometer. Films were then taken in frontal, oblique, and lateral projections. Following this, more films were obtained with the rays directed horizontally and the patient lying on either side, in order to observe the spread of the material and the dilatation of occluded tubes.

In a normal salpingogram the intramural and isthmic portions of the tube are narrow and its folds of mucous membrane are imperceptible. In its more distal ampullary portion the tube is of somewhat increased caliber and its villi form high, slender, longitudinal folds which are visible roentgenologically.

It is in the ampullary portion of the tube that tuberculosis causes its greatest damage. Depending upon the increasing severity of change in this area, the author classifies tubal tuberculosis into three groups:

1. Tubes showing thickening of mucosal folds. This reflects an initial involvement with mucosal thickening due to granulomatous or hypertrophic change.

2. Tubes of irregular contour showing loss of mucosal pattern. This reflects caseation and destruction. Irregular contours were caused by coalescence of villi and the formation of small channels and cavities.

3. Tubes lacking mucosal pattern, occluded in the isthmic or ampullar portion, and often slightly dilated. In many cases tubes were slightly distended distally, giving a club-like appearance.

In the uterus the typical changes consisted of marked deformity of the uterine cavity, often associated with cavities and fistulas in the wall. The contours were sometimes notched and dentate. Constrictions were frequent. The cervix was often involved. If the wall was only slightly notched or irregular, or contained small intramural cavities as in adenomyosis, the appearance was not characteristic.

The following points are significant in the differential diagnosis: Extensive hydrosalpinx occurs only rarely in tuberculosis, but commonly follows salpingitis of other types. Occasional narrow mucosal folds with slight or moderate hydrosalpinx were not found in the tuberculous series. A moderately hypertrophic mucosal pattern in tubes showing dilatation of varying degrees may be either tuberculous or non-tuberculous. Very marked thickening of mucosal folds occurs only in tuberculosis. Tubes of irregular contour showing loss of mucosal pattern afford almost conclusive evidence of tuberculosis. The same applies to the club-like tubes in which the isthmic lumen is slightly dilated and the ampulla occluded by a stricture. Multiple strictures in the ampullar portions are also typical of tuberculosis. Tuberculosis is almost always bilateral. Consequently the visualization of a normal tube or unilateral pathology suggests another diagnosis. Tuberculous endometritis with roentgenographically demonstrable changes in the tubes is held to be evidence of tubal tuberculosis. Small, irregular calcifications in the tubes or ovaries and perceptible abscesses or lymph nodes contribute to the impression that tuberculosis is present.

Patients receiving antibiotics tended to have a reversion toward normal of the otherwise progressive changes.

Forty-five figures, including 89 roentgenograms.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

**The Role of Hysterosalpingography in the Diagnosis of Genital Tuberculosis in Woman.** Olli Ylinen and C.-E. Johanson. Ann. chir. et gynaec. Fenniae, Vol. 44, Supplement 2, 1955.

The authors report an extensive study of the usefulness of hysterosalpingography in the diagnosis of proved genital tuberculosis. Their study comprised 139 examinations performed on 104 genital tuberculosis patients seen at the Women's Clinics of Helsinki University from 1945 through 1954. The findings in 99 patients (120 hysterosalpingograms) were analyzed, and the results were compared with the work of Ekengren and Rydén (Acta radiol. **34:** 193, 1950; **36:** 485, 1951. Abst. in Radiology **57:** 292, 1951; **59:** 919, 1952).

These separate studies are in agreement as indicating that the diagnosis of tuberculous salpingitis can be made with a very high degree of accuracy in a large number of cases by hysterosalpingography. In genital tuberculosis, salpingitis occurs in 90 to 95 per cent of cases. The tubes are often closed. When open, they frequently lead to adhesion cavities in the pelvis. The authors concur with the following classification of Ekengren and Rydén as being typical of tuberculous salpingitis:

I. Slightly dilated, club-like tubes with even contours and without mucous membrane relief, closed in the beginning of the ampulla or in the isthmus.

II. Tubes closed in the isthmus or the beginning of the ampulla with an irregular or ragged contour at the point of occlusion.
III. Tubes with multiple strictures in the ampullar or isthmic region.
IV. Moderately dilated tubes without mucous membrane relief in the ampulla.
V. Dilated tubes with hypertrophic, longitudinal, regular mucous membrane relief in the ampulla.
VI. Dilated tubes with irregular, hypertrophic mucous membrane relief in the ampulla.
VII. Slightly or moderately dilated tubes with ragged irregular contours and irregular contrast defects in the ampulla.

The diagnosis of tuberculous endometritis and cervicitis occurring alone cannot be made, but endometrial and cervical changes associated with known tuberculous salpingitis may be considered significant. Calcifications in the ovaries and in the pelvic lymph nodes are almost always of tuberculous origin and support the suspicion of genital tuberculosis.

The performance of hysterosalpingography in patients with genital tuberculosis has not resulted in any significant complications. The authors observed no re-activation of genital tuberculosis. This lack of complications was attributed particularly to the use of water-soluble contrast media.

Hysterosalpingography may result in intravasation of the medium into the wall of the uterus or the lymph vessels or veins, but this complication is not specific for genital tuberculosis, as it often occurs in other extensive inflammatory diseases of the uterus.

Hysterosalpingography was performed between the sixth and seventh days of the menstrual cycle. A condition was that the sedimentation rate did not exceed 15 in an hour. Up to 1950, various oily contrast media were used, but these were subsequently replaced completely by water-soluble or so-called viscous contrast media. After the instruments are placed in position, 2 to 3 c.c. of pontocaine solution (1:1000) is injected to provide mucous membrane anesthesia. The contrast medium (10 to 20 c.c.) is then injected under fluoroscopic control, and films are exposed.

Thirty-two roentgenograms; 7 tables.

JOHN P. FOTOPOULOS, M.D.
Hartford, Conn.

**Foreign Body Granulomas Following Hysterosalpingography with a Contrast Medium Containing Carboxymethyl Cellulose.** F. Bergman, G. Gorton, O. Norman, and S. Sjöstedt. Acta radiol. **43**: 17–29, January 1955.

Recently viscous water-soluble contrast media containing carboxymethylcellulose (Medopaque H and Dionosil) have been used in hysterosalpingography. Since granulomatous formations were reported in operative specimens following use of these substances, the present investigation was undertaken.

Granulomas were found in 16 of 18 specimens which were specifically studied and in 7 of 46 cases in which available slides were reviewed. Histologic and staining characteristics of the lesions convinced the authors that carboxymethylcellulose was the causative agent. The distribution of the lesions closely followed the radiographic distribution of the medium. None of the lesions were found in the abdominal cavity if no spillage had occurred during the roentgen procedure. The granulomas develop rapidly (in one to two days) and may persist for many years.

Although the clinical importance of these changes is still debatable, the authors believe that contrast media containing carboxymethylcellulose should not be used in women of fertile age. They have completely discontinued the use of these products in their clinic.

Seven photomicrographs; 1 table.

LAWRENCE A. DAVIS, M.D.
University of Louisville

## THE GENITOURINARY SYSTEM

**Normal Micturition: Certain Details as Shown by Serial Cystograms.** Frank Hinman, Jr., Gerald M. Miller, Eldon Nickel, Howard L. Steinbach, and Earl R. Miller. California Med. **82**: 6–7, January 1955.

Serial cystograms of normal women were made during micturition at one-second intervals. The relaxed bladder emptied differently than did the already contracted bladder. The subject who did not have the urge to void emptied the relaxed bladder by contraction of the detrusor followed immediately by lowering of the bladder base. The internal and then the "external" sphincters opened, and voiding occurred. When the bladder was contracted, in association with the urge to void, the internal sphincter was already open. Upon the effort to void, the bladder base was lowered and the external sphincter opened.

Voluntary cessation of urination before the bladder was empty was accomplished by closure of the external sphincter followed by elevation of the pelvic floor and relaxation of the detrusor.

Five roentgenograms; 1 diagram.

JOHN F. WEIGEN, M.D.
Palo Alto, Calif.

**Foreign Body in the Left Kidney and Ureter.** Bela Gondos. J. Urol. **73**: 35–38, January 1955.

Only 32 cases of foreign bodies in the upper urinary tract have been reported. Penetration from external injury, as by bullets or particles of explosives, penetration from the gastrointestinal tract, and retrograde migration from the lower urinary tract are the three known routes of entrance. Usually the right kidney is involved when the foreign body penetrates the duodenal wall, but either kidney may be entered through a perforated colon. Infection is invariably present with foreign bodies.

The case of a 70-year-old man with a two weeks history of fever, chills, and left flank pain is presented. A large indefinite mass was palpated in the left kidney region, and on retrograde pyelography a partially opacified abscess cavity was demonstrated in the lower pole of the left kidney. At operation a large inflammatory mass including the left ureter and adjacent peritoneum was found. The kidney was a pyonephrotic sac containing a calculus and a fish bone 6 cm. in length. Complete recovery followed total nephrectomy. Though no history of a swallowed fish bone could be elicited, it is postulated that it had penetrated the wall of the colon. The foreign body was not visualized on the x-ray film.

This is only the second recorded case of a foreign body from the gastrointestinal tract perforating the left ureter and kidney. Fricke (Ztschr. f. Urol. **37**: 130, 1943) reported a case in which a 5-cm. fish bone per-

forated the left ureter with ureteral wall swelling and complete upper urinary tract obstruction. Blaine (Radiology **12**: 207, 1929) discovered a needle embedded in the left kidney but the source was undetermined.

One roentgenogram. WILLIAM H. NEIL, M.D.
University of Pennsylvania

**A Contribution to the Diagnosis of Renal Adenoma.** Jan Kučera and Čestmír Dvořáček. Acta radiol. & cancerol. bohemoslov. **8**: 163–173, July 1954. (In Czechoslovakian)

Three cases are reported in which nephrectomy was done for what subsequently proved to be benign adenomas. In 2 cases the presence of the tumor was determined by pyelography; in the third case it was discovered during operation which had primarily been intended for nephroptosis. In each instance the cells presented a compact granular cytoplasm. While in one tumor they showed a cystopapillary arrangement and were basophile, in the others a solid trabecular pattern and eosinophilic granulation were observed. The benign nature of the third and smallest tumor might be questioned because of the presence of atypical hyperchromic nuclei, but there was no evidence of metastasis. In the differential x-ray diagnosis between malignant neoplasm and benign adenoma of the kidney, retroperitoneal air insufflation may give valuable information.

Four roentgenograms; 3 photographs; 4 photomicrographs. E. A. SCHMIDT, M.D.
Hilo, Hawaii

**Urethrography in the Male: The Boundaries of the Different Urethral Parts and Detail Studies of the Urethral Mucous Membrane and Its Motility.** Olallo Morales and Ragnar Romanus. J. Urol. **73**: 162-171, January 1955.

The authors point out that comparatively little use of urethrocystography has been made in the past except in gross lesions or deformities. This they attribute in part to the fact that previous methods were not ideal for a more detailed examination. They present a new procedure which they feel allows a much more informative study. It is based on fluoroscopically controlled contrast injection pictures with moderate distention of the lumen of the urethra, followed by emptying films with only a thin layer of the medium covering the mucous membrane.

The properties of the contrast medium are of the utmost importance. For examination of the urethra, a high degree of opacity to x-rays, water solubility, wetting qualities, and a high viscosity are important. A highly viscous solution has a low velocity and as it flows into the bladder, the pressure exerted on the walls of the posterior urethra is increased, resulting in good distention of that part. A second advantage is that the slower filling and evacuation of the posterior urethra permit better control of the procedure and allow fluoroscopic examination of both phases. The contrast medium used by the authors is Umbradil U (Astra). They have previously reported their experience with this medium in Supplement 95 of *Acta radiologica* (Abst. in Radiology **62**: 303, 1954). For a satisfactory flow, the injection pressure must be much greater than with solutions of lower viscosity, but this can be easily obtained with an ordinary hand syringe.

The procedure described permits observation of the relative movement of the anatomical structures in the vicinity of the posterior urethra and the bladder neck during "straining down" and contraction of the pelvic floor (to interrupt urination). Such motility studies, the authors believe, are frequently more informative than the micturition examination for determining possible fixation of the structures in this region, such as is seen in perivesiculitis or infiltration by prostatic cancer. They point out, however, that the latter procedure should always be attempted, as it is the best type of examination for the micturition mechanism.

Evacuation of the posterior urethra, which occurs with contraction of the pelvic floor, allows one to determine the boundary between the prostate and the diaphragmatic portion of the urethra. The boundary between the anterior and posterior urethra can also be determined, as well as the boundaries of the pars nuda of the anterior urethra.

On the evacuation film the normal urethra is seen to empty as a result of the elasticity of the mucous membrane, leaving a thin streak of contrast medium within the lumen. When elasticity is decreased, as in the early phase of stricture, the evacuation films reveal segments of dilated lumen.

A complete urethrographic examination includes a frontal and two oblique radiographs taken under fluoroscopic control during injection with the lumen fully distended and again with contraction of the pelvic floor, as well as an oblique view obtained during micturition.

Twenty-three roentgenograms.
RICHARD E. ERNST, M.D.
University of Pennsylvania

**Spermatocystography in Patients with Spinal Cord Injuries.** A. Estin Comarr and Ernest Bors. J. Urol. **73**: 172-178, January 1955.

Experience with spermatocystography accumulated in 50 patients with cord lesions extending in level from C-4 to L-3 is reported. The object was to determine whether with such lesions radiographic changes are demonstrable in the spermatic vesicles. In addition to the radiographic investigation, seminal washings and sperm counts were obtained in all cases; in 25 testicular biopsy was done.

The vas was exposed surgically on each side, and through a No. 23 needle 15 to 20 c.c. of 35 per cent Diodrast was injected after seminal washing with 5 per cent saline. No instances of pain from distention and no reactions to the contrast material were observed. In some patients the procedure was repeated without incident. Each side was injected, films of one side being made before injection of the second side.

The films were classified, according to the suggestion of Pereira (Am. J. Roentgenol. **69**: 361, 1953. Abst. in Radiology **62**: 464, 1954), as showing normal findings, ectasia, hypoplasia, or secondary atrophy.

While bilateral spermatocystography was attempted in all cases, there were 6 in which only one side could be injected, and in 1 case there was obstruction to the flow of the medium on both sides. No correlation could be found between the level of cord injury, the patient's age (nineteen to seventy years), the duration of the cord lesion, or the testicular biopsy and the findings on spermatocystography. Nor was there any correlation between the sperm count, motility of the sperm, the level and extent of the injury, and the testicular biopsy.

The absence of pain from cord distention even in patients whose sympathetic nerve supply was intact suggests that the afferent pain fibers may travel with the parasympathetic nerves. Further, the presence of ectasia in nerve injuries at all cord levels indicates that the nerve supply is not exclusively sympathetic in origin.

The lack of sperm in the washings of the seminal vesicles again indicates that these structures are not a storage space for sperm. The spermatic washings were considered unsatisfactory for artificial insemination.

Seven roentgenograms; 1 table.

THEODORE A. TRISTAN, M.D.
University of Pennsylvania

## TECHNIC

**Rotation Tomography at Small Angles.** Knut Lindblom. Acta radiol. **43:** 30-36, January 1955.

The author describes a technic for improving tomography by decreasing the angle of movement of the tube. This results in less distortion and a marked diminution in the amount of blurring of the central object. A shortened exposure time is also then possible. Several excellent examples of this type of tomogram are included.

Twenty-eight roentgenograms; 2 diagrams.

S. G. BELOTE, M.D.
University of Louisville

## RADIOTHERAPY

**A Method of Pre-operative Roentgentherapy by High Doses, Followed by Radical Operation for Carcinoma of the Breast (Showing Survivals up to 10 Years).** F. Baclesse. J. Fac. Radiologists **6:** 145–163, January 1955.

During the period 1935–46, 77 cases of carcinoma of the breast were treated at the Fondation Curie, Paris, by high-dose, highly fractionated roentgen therapy followed by radical surgery. This method of treatment was carried out (1) to determine whether, and under what conditions, mammary tumors could effectively be "sterilized" by roentgen therapy and (2) to discover, by scrutinizing the results, any information which would help in the problem of treatment by irradiation alone.

In the preoperative irradiation of breast cancer, two segments are distinguished, the *surgical segment*, consisting of the breast and axillary fields, and the *radiological segment*, comprising the internal mammary chain and supraclavicular fossa. The dosage to the "surgical segment" must not exceed the limit of tissue tolerance if postoperative complications are to be avoided; that to the "radiological segment" should be higher and designed to bring about sterilization if possible.

*The Surgical Segment:* Two breast fields are employed, medial and lateral, treated strictly *en profil*, right and left alternately, the patient lying in the lateral decubitus position. Each field is given a maximum total skin dose of 4,000 r (it is advisable, until one is fully experienced in the technic, to stop at 3,000 r). The administration of the dose (at 180 kv, which was used in the present series) must follow a certain rhythm where the maximum dose does not exceed 2,000 r per field at the end of the sixth week nor 2,400 r per field at the end of the seventh week, to reach the 4,000 r maximum at the end of the tenth week.

The axillary fields, one direct with the arm raised and the other anterior with the arm abducted at a right angle, are irradiated to a maximum dose of 2,000–2,200 r each over six weeks and 2,500 r in seven weeks, with two treatments per week of 200 to 250 r each.

*The Radiological Segment:* This segment receives high doses, 6,000 r for the internal mammary chain and 4,000 and 5,000 r for the supraclavicular field. The fractionation is of the order of twelve weeks at a rate of two treatments a week (200–250 r per treatment). The fields are irradiated alternately following a regular cycle.

Surgery is performed about two months after completion of the irradiation of the surgical segment, or even later.

This series of 77 cases included none in Stage I (Steinthal). Three patients had already had a local recurrence after conservative mastectomy elsewhere, while the remaining 74 had received no previous treatment. Seventy-two patients were subjected to radical mastectomy, while 5 for various reasons only had a simple mastectomy. Thirty-four (44 per cent) were considered clinically cured after five years and 27 (35.5 per cent) after ten years. The criteria for clinical cure were the disappearance of the primary tumor and involved lymph nodes, together with apparent absence of distant metastases.

Thirteen figures; 16 tables.

**Lymphangiosarcoma in Postmastectomy Lymphedema. Five-Year Survival with Irradiation Treatment.** Harry W. Southwick and Danely P. Slaughter. Cancer **8:** 158–160, January-February 1955.

The authors report a case of lymphangiosarcoma in a postmastectomy lymphedematous extremity with five-year survival following irradiation treatment. This is the fifteenth reported case of lymphangiosarcoma occurring in these circumstances.

The patient, a 49-year-old woman, was referred to the authors eight years after mastectomy because of multiple small lesions involving the skin of her lymphedematous arm. The original breast lesion was an adenocarcinoma without nodal metastases. The patient refused interscapulothoracic amputation and was given a course of roentgen therapy. Treatment was carried out over a period of one month. Six ports, each 15 × 15 cm., were utilized to cover the entire extremity with the exception of the hand. Four doses of 400 r each were administered to each area, only one port being irradiated daily. Physical factors were 200 kv, 18 ma, 50 cm. distance, with 0.5 mm. Cu and 1.0 mm. Al filtration.

The lesions regressed early in the course of treatment and were completely gone six weeks after termination of therapy. Five-year follow-up showed marked irradiation fibrosis but no evidence of tumor.

It is the authors' opinion that the treatment of choice is a carefully planned course of irradiation unless other considerations justify amputation.

Three photographs; 2 photomicrographs.

THEODORE E. KEATS, M.D.
University of California, S.F.

**Deep X-Ray Therapy in Gynaecology.** E. J. B. Hardcastle. M. J. Australia **1:** 68–72, Jan. 15, 1955.

This paper on the use of deep x-ray therapy in malignant and non-malignant gynecological conditions was

read at a meeting of the British Medical Association and is of a rather general nature. The author's discussion is based largely on a review of the literature.

**Further Observations on Tissue Dosage in Cancer of the Cervix Uteri.** Manuel Garcia. Am. J. Roentgenol. **73:** 35–58, January 1955.

Utilizing a study of 943 cases, the author attempts a correlation of therapeutic results with radiation dose employed. All of the patients were followed to death or five or more years beyond treatment. Seven hundred and three cases in the series are considered to have been fully treated and these are used for the statistical analyses. Dosage from roentgen and gamma rays is calculated at Points A and B as defined by Tod and Meredith. An arbitrary correction factor is used in adding gamma-ray to roentgen-ray dosages. The calculated gamma-ray dose is multiplied by 0.67 before adding it to the roentgen dose. The author believes that the paracervical dose ("Point A") serves as an indicator of the dose received by the primary tumor. The parametrial dose ("Point B") gauges the amount received by the more peripheral areas of possible tumor invasion, and is also considered to be a guide to the tolerance of the entire block of tissue which has been subjected to heavy dosage.

The dose of radiation administered to any patient is thought of as having "four dimensions": quantity, quality, distribution in time, and distribution in space. The problem is one of finding a method whereby the variation in these four magnitudes or dimensions may be adjusted to a single parameter or yardstick, which may then be used for correlation with biological effects. The author admits that only an approximate solution of the problem is possible at this time.

Tumor doses are calculated as described above at Point A for 275 five-year survivors. The results are plotted on a graph to obtain what is called a "regression line," presumably representing a satisfactory tumor dosage. The graph demonstrates the dose-time relationship. A formula is derived mathematically to express this relationship and is found to be represented as follows:

$$D = 2575\, t^{0.33}, \text{ where}$$

$D$ = the mean effective paracervical dose (corrected for quality as above) and $t$ = the number of days over which treatment is given.

By a similar but more difficult process, the dosage calculation and formula derivation for Point B are accomplished. This calculation is believed to represent a close estimate of the tolerance dosage in the pelvis and is again a time-dose relationship approximately expressed as follows:

$$D_B = \frac{4200}{r0.45}\, t^{0.25}, \text{ where}$$

$D_B$ = the mean effective parametrial dose corrected for quality; $t$ = the number of days over which treatment is given; $r$ = the radius of the cross-sectional area under treatment at the parametrial level.

Conclusions are that, despite the different stages of tumor under therapy, survival rates appear to improve steadily as the paracervical dose rises to the tolerance level. Contrary to what has been previously thought, it is shown by these results that survival rates become significantly impaired when the parametrial dose is excessive. This factor is particularly evident in Stage I and Stage II cases, where optimal results are accomplished by less than maximum dosage. In more advanced lesions, however, a better survival rate is obtained with higher dosages and larger fields. Better results are attained when parametrial doses coincide with the tolerance level, and recovery is decreased when either lesser or larger doses are given at Point B. The sequence of application of radium and roentgen therapy did not appear to influence salvage rates, but patients receiving both agents did better. Grossly infected tumors responded more favorably when roentgen therapy was given in smaller daily doses over a longer period of time.

This is a highly technical article which does not lend itself well to abstracting. Extensive mathematical maneuvers are employed to demonstrate the points under discussion, and for these the original must be consulted. The paper continues a study first reported in Radiology **40:** 463, 1943.

Four graphs; 23 tables. J. W. BARBER, M.D.
Cheyenne, Wyo.

**Carcinoma of the Cervix Uteri Treated at the American Oncologic Hospital, 1929–1949.** George A. Hahn. Am. J. Obst. & Gynec. **69:** 48–58, January 1955.

The author presents an evaluation and analysis of 288 cases of carcinoma of the cervix treated by irradiation, with a 95 per cent follow-up. Abnormal vaginal bleeding was by far the most prominent symptom, with vaginal discharge next in frequency. Eighty-five per cent of the patients were parous, and 32.6 per cent were under forty years of age; 4.5 per cent had positive Wassermann tests; almost one-third had undergone previous pelvic surgery.

The general plan of treatment consisted of intracavitary radium application and external roentgen irradiation. Variations from this general plan included the use of a radium bomb and roentgen irradiation through a vaginal cone. The five-year survivals were as follows: for 53 cases of Stage I, 52.8 per cent; for 41 cases of Stage II, 46.3 per cent; for 82 cases of Stage III, 35.3 per cent. Of 112 patients with Stage IV disease, none lived five years. The rate of serious post-irradiation complications was 3.5 per cent.

There were 28 patients with carcinoma of the cervical stump (incidence 9.7 per cent), and for these the five-year survival rate was 21.4 per cent.

Three figures; 3 tables. R. L. EGAN, M.D.
M. D. Anderson Hospital, Houston

**The Management of Certain Nonlipid Reticuloendothelioses.** Alan C. Mermann and Harold W. Dargeon. Cancer **8:** 112–122, January-February 1955.

The authors discuss the management of the non-lipid reticulo-endothelioses on the basis of a series of 28 cases gathered over twenty-two years at Memorial Center (New York). Diagnosis was based on histologic examination. Thirteen of the cases were eosinophilic granuloma. For these, simple curettage is adequate. Fractionated roentgen therapy in a dose range of 200 to 400 r will also usually cause complete healing. The authors favor surgical therapy, since diagnosis depends on biopsy and they feel that radiation therapy may be unwarranted for this benign process.

Ten cases of Hand-Schüller-Christian's syndrome were included in the series. Roentgen therapy is the quickest method available for repair of the bone lesions

and relief of exophthalmos in this condition, but here also the use of what many observers consider a radical therapeutic agent may not be justified. This attitude, along with the frequent occurrence of new lesions elsewhere during the course of therapy, has led to a search for other effective agents. Gratifying results with folic acid antagonists are mentioned and their more general use is suggested.

There were 4 cases of Letterer-Siwe's syndrome. All proved fatal, and the failure of any agents other than nitrogen mustard to alter the course of the illness is mentioned. The clinical and histologic similarity to a neoplastic process, such as monocytic leukemia, is noted.

The final case in the series resembled Letterer-Siwe's disease pathologically but the clinical course was not characteristic.

The authors do not regard the entities described as all different manifestations of the same process. Letterer-Siwe's disease is believed to represent a neoplastic rather than an infectious process.

Six roentgenograms; 5 photographs; 3 tables.

THEODORE E. KEATS, M.D.
University of California, S.F.

**The Neural Conception of the Treatment of Purulent Skin Diseases by Roentgen Irradiation.** C. Vojtek. Acta radiol. & cancerol. bohemoslov. **8:** 145–152, July 1954. (In Czechoslovakian)

The author reports his experience in the x-ray treatment of 176 cases of purulent skin disease as, for example, furuncles and wound infections. The history and rationale of radiation therapy in inflammations are discussed, and the usual methods of approach are found wanting in results. The shortcomings of these methods lie mainly in the fact that they fail to take into consideration the role of nervous influences, especially of the central nervous system, which is considered the leading factor in the reaction of the organism to inflammation. Small x-ray doses exert an inhibitory and regulatory effect on the inflammatory focus through changes in the nervous system which modify and accelerate the healing process. Basing his conclusion on his improved clinical results, the author recommends very small doses (5 to 10 r per field).

Two tables.

E. A. SCHMIDT, M.D.
Hilo, Hawaii

**Radiotherapy of Arthrosis, Spondylosis, Periarthritis Humeroscapularis and Epicondylitis.** P. Hess and K.-H. Bonmann. Strahlentherapie **96:** 75–81, January 1955. (In German)

In radiotherapy of arthrosis deformans, alleviation of pain is achieved by decrease of the inflammatory components and by the direct analgesic effect of the radiation. Of 497 patients, 55 became asymptomatic, 213 improved, and 225 were unchanged. Other results reported were as follows:

| | |
|---|---|
| Spondylosis deformans | 170 cases |
| Asymptomatic | 29 (17%) |
| Improved | 78 (46%) |
| Unchanged | 63 (37%) |
| Periarthritis humeroscapularis | 116 cases |
| Asymptomatic | 58 (50%) |
| Improved | 42 (36%) |
| Radioresistant | 16 (14%) |
| Epicondylitis humeri | 65 cases |
| Asymptomatic | 35 (54%) |
| Improved | 23 (35%) |
| Radioresistant | 22 (11%) |

Seven tables.

LEWIS L. HAAS, M.D.
Chicago, Ill.

**Equipment and Technique in Precision Rotation Roentgen Therapy.** S. Benner, O. Dahl, S. Hultberg, R. Thoræus, and K. J. Vikterlöf. Acta radiol. **43:** 65–80, January 1955.

The authors present a detailed description of the physical plant and technic for rotational roentgen therapy as now used at the Radiumhemmet, Stockholm. They have succeeded in delivering an accurately calculated tumor dose, observing the following conditions: (1) continuous fluoroscopic control for accurate direction of the therapeutic beam; (2) perfect fixation of the patient on the rotation chair, to maintain a constant distance between focus and tumor center; (3) direct measurement of tumor dose by a condenser chamber within the affected organ or tumor; (4) use of individually adapted compensating filters to flatten the dosimetry curves. Accuracy of tumor dose is at least equal to that attained by the multiple-field technic. Discomfort to the patient is minimal and skin changes are mild.

While the apparatus described is designed primarily for the treatment of intrathoracic tumors, the authors have treated also carcinoma at the junction of the hypopharynx and esophagus and in 5 cases have irradiated the pituitary (2 cases of thyrotropic exophthalmos; 2 of Cushing's disease; 1 of acromegaly).

Three photographs; 2 diagrams.

THOMAS E. PADGETT, M.D.
University of Louisville

**Microlocalized Radiotherapy.** Carlos Santos. Strahlentherapie **96:** 47–63, January 1955. (In German)

Irradiation of the pituitary by the usual technic is not adequately circumscribed, as the hypothalamus is also included. The author has devised a method permitting irradiation of the pituitary alone, of either the anterior or the posterior lobe, or of the hypothalamus alone.

The patient's head is fixed in a cage the base of which is formed by a cassette tunnel. Into the roof is built a ring containing 20 radiopaque numerals from 0 to 19 and a double number of marker dots. X-ray film taken through the axis of the ring shows the sellar region within the markers. On the film the area of interest is delineated by plastic strips which cross certain points of the marker shadows. Identical marker points on the roof of the cage will determine the position of covering lead plates so that only the minute area delineated on the film remains exposed to irradiation.

Film localization of this type is indicated in all lesions and syndromes related to the pituitary gland or hypothalamus. The author has used the procedure in rheumatic diseases, irradiating the anterior pituitary lobe in 33 cases to influence ACTH formation, and the hypothalamus in 5 cases. He treated, also, 3 cases of diabetes insipidus and 3 cases of sphenoid sinusitis. The results are reported as favorable.

Seventeen figures, including 3 roentgenograms.

LEWIS L. HAAS, M.D.
Chicago, Ill.

**Treatment of Malignant Tumors of the Tonsillar Region and Soft Palate.** P. Kisfaludy, F. Vándor, and A. Temesvári. Strahlentherapie **96:** 14–29, January 1955. (In German)

This review is based on experience with 262 cases of carcinoma of the tonsils and soft palate. With few exceptions, surgery is contraindicated in tonsillar carcinomas. Biopsy is essential and does not impair the prognosis. For extensive lesions x-ray therapy should be given through three fields: infrazygomatic, retromandibular (both directed toward the uvula), and a contralateral field, up to a total dose of 2,000 to 3,000 r per field, in daily doses of 200–250 r. If the lesion is less extensive, being limited to the anterior pillar and soft palate, implantation of radium needles is preferable. Needles of 1, 2, and 3 cm. active length are used, 3.3 mg./cm., implanted 12 mm. apart, for eighteen to twenty-six hours. Neck nodes are removed by radical neck dissection.

Six roentgenograms; 10 photographs; 4 figures.

LEWIS L. HAAS, M.D.
Chicago, Ill.

**Convergent Beam Roentgen Tube.** C. H. Bachman, H. W. Davis, and O. J. Gelormini. Am. J. Roentgenol. **73:** 103–109, January 1955.

The authors describe the construction of a special x-ray generating tube designed to produce a convergent beam. Fundamentally it consists of a central axial filament surrounded by a specially shaped target, in the form of a hollow metallic cone, inverted and truncated. A disk-shaped collimator interposed in the beam axis in front of the tube window produces a hollow sheath of x-rays emerging from the tube. The crossover point of this hollow sheath of x-rays (the beam "focal point") lies outside the tube and is determined by the angle of the surface of the cone-shaped target. Through any plane perpendicular to the cone axis, a ring-shaped beam of radiation passes, directed toward a common point. A geometrical gain in radiation intensity at the crossover area arises because all of the radiation in the ring of x-rays leaving the tube window passes through a relatively much smaller area at the crossover point. The resultant geometrical effect is similar to a circular rotational technic.

The authors discuss the physical effects arising from the thickness of the radiation sheath, which is controlled by the size of the central plug collimator and the angle of the target cone. Some comparative isodose charts show depth doses with conventional tube targets and with the special tube described. It is evident that in the low kilovoltage studies conducted, the convergent beam tube produces a much higher percentage depth dose, particularly in the 2 to 6 cm. depth range. Depth dose curves are constructed at 30, 40, and 50 kv for various depths in Masonite phantoms.

Six diagrams; 4 charts; 3 photographs.

J. W. BARBER, M.D.
Cheyenne, Wyo.

**Near Surface Measurements of Small Gamma Emitters by Cadmium-Sulfid Crystal Probe.** R. Plesch and A. Schaal. Strahlentherapie **96:** 118–123, January 1955. (In German)

The authors describe a probe gamma meter constructed of cadmium-sulfid crystals in the form of thin platelets of 0.05–0.03 mm. thickness, 3.0 mm. breadth, and 4 to 6 mm. length. The whole thickness of the probe was 4.6 to 5.2 mm. Tests with 10 mg. radium tubes showed that the meter can practically be regarded as a point-like radiation receiver. The receiving point is located in the axis of the probe, and its distance from the end can easily be determined.

Five figures; 1 table.

LEWIS L. HAAS, M.D.
Chicago, Ill.

## RADIOISOTOPES

**Radioactive Isotopes as Aids in Medical Diagnosis.** Edith H. Quimby. New England J. Med. **252:** 1–9, Jan. 6, 1955.

By way of introduction, the author presents some general considerations of radioactive isotopes, including a definition of isotopes, a description of the disintegrations and half-life values of radioactive elements, and explanations of the expressions of quantity of a radioactive material. This general discussion is followed by comments on the character and properties of the emissions, on the limitations imposed by the effective half-lives and the radiations of the isotopes in their selection for diagnostic tests, and on the avoidance of chemical and radioactive effects in the physiologic functions to be tested.

The author details the diagnostic aids currently in use [the paper was presented in 1953] involving radioactive isotopes and discusses four phenomena upon which these are based: (1) dilution of a known amount of isotope, to determine the volume of the diluting fluid; (2) the rate of transfer from one part of the vascular system to another, to ascertain some fact about the circulation; (3) the rate of disappearance of an isotope that has been injected directly into a certain tissue to reveal the state of the local circulation in that tissue; (4) the concentration of the isotope in a particular organ or tissue, to determine something about the local function of that tissue.

The dilution studies permit determinations of the volume of blood, plasma, and red cells. Human serum albumin, tagged with radioiodine, remains in the plasma and is most frequently employed in the blood-volume determinations. [The paper was presented prior to the wide application of radioactive chromium for these volume studies.] Indications of extracellular fluid volumes can be obtained by a dilution technic, with the aid of various radioactive elements that are involved in the exchange of extracellular fluids between the circulatory system and cellular spaces. A precise quantitation of the extracellular fluid volume has not been possible, however, since the indicator elements also enter the cells in various degrees.

The rate of transfer of a radioactive material from one point to another has wide application. Circulation times between any two points of reference can be obtained, and this technic has been applied in various physiologic and pathologic states. "Radiocardiography," a tracing following the transfer of radiosodium through the heart and lungs, has been developed.

The rate of disappearance of an isotope has been used in tubed pedicle grafts. The clearance time of radiosodium after direct injection indicates the ade-

quacy of the circulation developed and whether the graft is ready for transplantation.

Concentration determinations are best exemplified by $I^{131}$ tracer studies for determining thyroid gland activity. Localization of tumors (*e.g.*, hepatic and intracranial) with iodinated human serum albumin is another example of a tracer technic that depends on the concentration of the radioactive substance in a particular tissue.

The original paper offers fuller details of principles and methods of each of these technics and constitutes an excellent summary of the applications of radioactive isotope tracers in clinical and investigative procedures.

In conclusion, the author observes that many have been disappointed that radioisotopes have not proved to be of miraculous consequence. The development of this field, however, is in its relative infancy, and an optimistic view is encouraged.

Eleven figures; 2 tables. J. E. WHITE, M.D.
University of Texas, Dallas

**Simplified Apparatus for Brain Tumor Surveys.** Herbert C. Allen, Jr., and J. R. Risser. Nucleonics **13:** 28–31, January 1955.

Significant localization of iodine, or other gamma-emitting isotopes, can be observed with a single crystal operated in conjunction with a pulse-height analyzer. The crystal is mounted inside a lead collimator which limits the actual volume of the body from which gamma rays can reach the crystal to a narrow cone. The length of the lead collimator serves not only to define the source of gamma rays but also minimizes the influence of the relative depth of a gamma ray source in the body on the number of gammas from it reaching the crystal. The pulse-height analyzer further makes possible selection of direct gamma rays and discrimination against scattered gamma rays which provide no information on the location of the original source. An example of the successful application of this apparatus to the localization of several metastatic lesions in the brain, with necropsy confirmation, is presented.

Seven figures. JOHN S. LAUGHLIN, Ph.D.
Memorial Center, New York

**Continuous Registration of Thyroid Uptake After Intravenous Injection of Radioactive Iodine. A Rapid Test of Iodine Concentrating Function of the Thyroid.** Lars-Gunnar Larsson and Lars Jonsson. Acta radiol. **43:** 81–88, January 1955.

The authors have found that measurements over the neck five to ten minutes following intravenous injection of $I^{131}$—the "initial neck curve"—give a good indication of the iodine-concentrating function of the thyroid, providing a continuous registration of the counting rates from the time of injection is performed. They use a gamma-sensitive scintillation counter.

The counts over the neck are derived from three sources: inorganic $I^{131}$ circulating in the blood; inorganic $I^{131}$ in the tissues, especially the extracellular fluid, due to its diffusion from the blood; $I^{131}$ taken up by the thyroid.

It is felt that this procedure probably gives a better quantitative picture of the iodine-concentrating capacity of the thyroid than deferred uptake measurements. A further advantage is that activity from $I^{131}$ remaining from previous tracer doses is a minor problem.

The disadvantages are as follows: (1) The dose must be given intravenously. (2) If the iodine-concentrating capacity of the thyroid is very low, the test cannot demonstrate whether any uptake is occurring or differentiate between various degrees of iodine-concentrating function. (3) Abnormal diffusion of $I^{131}$ may influence the initial neck curve.

Seven diagrams. JOHN F. BERRY, M.D.
University of Louisville

**Treatment of Incapacitated Euthyroid Cardiac Patients with Radioactive Iodine. Summary of Results in Treatment of 1,070 Patients with Angina Pectoris or Congestive Failure.** Herrman L. Blumgart, A. Stone Freedberg, and George S. Kurland. J.A.M.A. **157:** 1–4, Jan. 1, 1955.

The results of treatment of 1,070 incapacitated euthyroid cardiac patients with radioactive iodine are reported. The data presented were obtained by questionnaire from 49 clinics and supplemented by the authors' own results. The authors and 45 of the cooperating clinics confined this treatment to those patients with angina pectoris or congestive failure who were incapacitated or unable to work despite all other medical procedures.

Approximately 75 per cent of 720 patients with angina and 60 per cent of 350 patients with congestive failure showed worthwhile improvement. Doses ranging from 10 to 50 mc of $I^{131}$ were used. Unduly large doses should be avoided to prevent radiation thyroiditis with resultant release of relatively large amounts of thyroid hormone into the blood stream, with temporary hyperthyroidism.

In the clinical management of these patients, small daily doses of thyroid are usually administered in order to maintain the lowest metabolic rate consistent with comfort.

In intractable cardiac cripples who are usually considered for surgery, hypothyroidism induced by radioactive iodine gives improvement through medical means without the risk and complications of an operation.

Two graphs; 1 table. THEODORE E. KEATS, M.D.
University of California, S. F.

**Iodinated Compounds in the Serum, Disappearance of Radioactive Iodine from the Thyroid, and Clinical Response in Patients Treated with Radioactive Iodine.** Richard S. Benua and Brown M. Dobyns. J. Clin. Endocrinol. & Metab. **15:** 118–130, January 1955.

It is not definitely known whether the appearance of significant amounts of butanol-insoluble organic iodine, diiodotyrosine, monoiodotyrosine, and triiodothyronine in the blood, or any one of these, can be related to the effects of radiation on the thyroid gland. The authors describe studies dealing with possible relationships between iodinated compounds appearing in the serum, the rate of disappearance of radioiodine from the thyroid, the amounts of radiation delivered to the gland, and the clinical response to therapy.

Triiodothyronine was detected in the serum in 19 of 31 patients, monoiodotyrosine in 14, and diiodotyrosine in 6. Evidence is presented to suggest that the presence of diiodothyronine is related to the effect of thyrotoxicosis and not to the effect of irradiation. The presence of diiodotyrosine appeared to be the result of radiation damage to the thyroid gland. Following radioiodine therapy, a change toward an increasing rate of

loss of $I^{131}$ from the thyroid may be an indication of radiation effect.

Six graphs; 3 tables. BENJAMIN KAUFMAN, M.D.
Cleveland City Hospital

**The Influence of Various Factors on the Uptake of Iodine by the Thyroid.** D. Ward Slingerland. J. Clin. Endocrinol. & Metab. **15:** 131–141, January 1955.

Using fresh sheep thyroid, the author studied the effects of 180 compounds, temperature variations, changes in pH, $O_2$ changes, varying thickness of thyroid, and different media, upon the iodide concentration gradient and respiration ($QO_2$). They summarize their observations as follows:

"Aerobic conditions were necessary for iodide concentration. Extremes of temperature and pH diminished the ability of the thyroid slice to accumulate iodide. Many compounds which react with sulfhydryl groups were found to diminish the iodide gradient. An inhibitor of iodide uptake may or may not empty out iodide already concentrated. Compounds which depress the iodide-concentrating capacity do not necessarily depress the respiration of the slice, though most of them do. A factor which increases slice respiration may increase the iodide concentration but no substance has been found to depress respiration without also depressing the iodide concentrating mechanism."

Ten graphs. BENJAMIN KAUFMAN, M.D.
Cleveland City Hospital

**The Metabolism of Iodine in 2 Goitrous Cretins Compared with That in 2 Patients Receiving Methimazole.** John B. Stanbury, Kalervo Ohela, and Rosalind Pitt-Rivers. J. Clin. Endocrinol. & Metab. **15:** 54–72, January 1955.

In an endeavor to elucidate the disorder of iodine metabolism encountered in goitrous cretins, the authors conducted studies of the metabolic fate of iodine in 2 such patients and compared the results with similar observations upon a patient with Graves' disease and another with a normal thyroid gland. Both of the latter received methimazole (1 methyl-2-mercaptoimidazole). The thyroid glands from the two cretins were obtained for analysis.

A detailed description of the methods used, the procedure employed with each patient, and a discussion of each case are given, with accompanying graphs.

Disposal of labeled iodide in one goitrous cretin was consistent with the hypothesis that the gland accumulated iodide but failed to convert it to an organic form. The declines in labeled iodide of the gland and blood were governed by the renal clearance of iodide. The absence of organic iodine in the gland was confirmed chemically. The total quantity of iodine in the gland was very small.

The subject with a normal thyroid gland and the patient with Graves' disease, when taking methimazole, disposed of iodide in a manner similar to that in the above-mentioned goitrous cretin, except that the iodide compartment of the gland of the patient with Graves' disease was larger and the methimazole block was incomplete. Renal excretion of iodide governed the metabolic fate of iodide in the subject with the normal gland, and nearly so in the patient with Graves' disease.

The other cretin had a compensatory goiter, a normal metabolic rate, and a high uptake of $I^{131}$. The disposal of labeled iodide was entirely different from that in the 3 other patients. Direct analysis demonstrated labeled thyroxine and triiodothyronine in the blood, but only a trace of thyroxine in the gland, although labeled monoiodotyrosine and diiodotyrosine were found in the gland in abundance. The explanation proposed is that organic binding of iodine by the gland was enhanced, but enzymatically controlled synthesis from iodinated tyrosine was impaired. BENJAMIN KAUFMAN, M.D.
Cleveland City Hospital

**The Mechanism of Induction and the Characteristics of Pituitary Tumors Induced by Thyroidectomy.** Jacob Furth, James Norman Dent, William T. Burnett, Jr., and Evelyn L. Gadsden. J. Clin. Endocrinol. & Metab. **15:** 81–97, January 1955.

The present report is a summary of all the relevant observations which have led the authors to the conclusion that sustained deficiency of thyroid hormone gives rise to thyrotropic pituitary tumors, whether the thyroid deficiency be brought about by ionizing radiation or by other agents.

Transplantation of pituitary tumors induced by thyroidectomy succeeds only in mice whose thyroids have been destroyed by $I^{131}$ or removed surgically. These tumors also grow in hosts subjected to subtotal thyroidectomy, but after a longer latent period and at a slower rate. The relation of proliferation of thyrotropic tumor cells to thyroid function is inverse and quantitative. In the course of continued subpassages in mice, these dependent tumors give rise to autonomous variants. The autonomous tumors grew better in normal than in athyroid hosts.

Pituitary tumors induced by radiothyroidectomy are composed of thyrotropes which proliferate in response to a sustained deficiency of thyroid hormone. Irradiation of the pituitary plays no significant role in the induction of these tumors. Pituitary tumors induced by total-body irradiation have a different hormonal spectrum.

Subtotal surgical removal of the thyroid, as well as its complete destruction or removal, will induce pituitary tumors. Residual thyroid tissue is apparently incapable of secreting enough thyroid hormone to maintain the physiologic balance between the thyroid and the pituitary. Autonomous thyrotropic tumors will stimulate the normal thyroid to undergo tremendous hyperplasia but the thyroid damaged by ionizing irradiation and the thyroid remnant after surgery will fail to show compensatory changes.

Administration of thyroid hormone will check the growth of primary thyrotropic pituitary tumors and first generation tumor grafts, since they are dependent on a deficiency of thyroid hormone.

Formation of adenomas, with invasive changes and metastasis to lymph nodes, is common in thyroids of mice that have been stimulated by the TSH of autonomous thyrotropic tumors. These changes are merely dependent growth disturbances and are not sustained in normal hosts, as are the metastasizing thyroid adenomas induced by thiouracil.

"The availability of dependent and autonomous tumors of both thyroid and pituitary, the ease of their induction, and the possibility of measuring their functions quantitatively provide an excellent basis for the study of thyroid-pituitary interrelationships and the problem of tumorigenesis in these organs."

Six photomicrographs; 2 photographs; 4 tables.
BENJAMIN KAUFMAN, M.D.
Cleveland City Hospital

**Pituitary and Adrenal Influences on Insulin-$I^{131}$ Degradation.** Neil J. Elgee and Robert H. Williams. Am. J. Physiol. **180:** 9–12, January 1955.

It has been recognized for some time that certain hormones of the adrenal cortex and anterior pituitary influence carbohydrate metabolism. The authors investigated the effect of the adrenals and pituitary on insulin metabolism, studying the distribution and degradation of insulin-$I^{131}$ in rats after (1) hypophysectomy, (2) adrenalectomy, and (3) treatment with hydrocortisone and/or growth hormone.

The radioactivity of insulin-$I^{131}$ is essentially all protein-bound. After injection into a rat, this property is rapidly lost. A fraction of radioactivity appears that is not protein-bound as measured by trichloracetic acid precipitation, and this supernatant fraction thereby represents degradation of the insulin-$I^{131}$. The method of measuring this degradation is described briefly.

It was found that insulin-$I^{131}$ degradation in rats is profoundly diminished after hypophysectomy. It is postulated that this phenomenon may contribute to the insulin hypersensitivity of the hypophysectomized animal. Adrenalectomized rats and rats treated with hydrocortisone and/or growth hormone showed little alteration in insulin-$I^{131}$ degradation, and no evidence was obtained to indicate that alterations of carbohydrate metabolism produced by such conditions are related to altered insulin degradation.

Four illustrations.

**Effects of Thyroid Function on Insulin-$I^{131}$ Degradation.** Neil J. Elgee and Robert H. Williams. Am. J. Physiol. **180:** 13–15, January 1955.

Alterations in thyroid function can markedly influence the course of diabetes mellitus. Insulin requirements greatly increase in thyrotoxicosis and decrease in hypothyroidism. Partially depancreatized animals can be made diabetic by the administration of thyroid hormone. In an attempt at a better understanding of these interrelationships, the authors have studied insulin metabolism at various levels of thyroid activity, using insulin-$I^{131}$.

One group of rats was given thyroxine, another group was given triiodothyronine, and a third group was subjected to thyroidectomy. All animals, as well as their controls, received insulin-$I^{131}$, injected intravenously. The degradation of insulin-$I^{131}$ in the rat was found to be increased by the administration of thyroxine or triiodothyronine and decreased by thyroidectomy.

Three illustrations.

**Hypothyroidism and Thyroid Hyperplasia in Patients Treated with Cobalt.** Joseph P. Kriss, William H. Carnes, and Ruth T. Gross. J.A.M.A. **157:** 117–121, Jan. 8, 1955.

Five cases are reported in which treatment of anemia with cobaltous chloride was followed by the development of thyroid hyperplasia and hypothyroidism. In 3 there was visible goiter. In 1 case there was severe myxedema.

The first case was that of a 4-year-old Negro boy with sickle-cell anemia who received 60 to 80 mg. of cobaltous chloride daily. Observation after seven months showed a large goiter. Iodine uptake by the thyroid at twenty-four hours was 12 per cent. Two weeks after cobalt was discontinued the uptake rose to 47 per cent and then dropped to 27 per cent in five months. Two of the other cases followed a similar course. In 2 further cases the hyperplastic thyroid was discovered at autopsy.

The most attractive hypothesis of the antithyroid effect of cobalt is that the drug inhibits one or more of the enzymatic reactions of the thyroid whereby inorganic iodide is oxidized, bound, and converted into thyroxin. It is reasoned that, because of the lack of thyroxin and related substances, the pituitary becomes overactive in the production of thyroid-stimulating hormone, which in turn results in the formation of goiter. We thus have hypothyroidism plus thyroid enlargement.

It is concluded that cobalt should not be used indiscriminately, especially in children. Only if there are urgent indications and the physician is fully aware of the hazards should it be employed.

Four figures; 3 tables. WILLIAM SNOW, M.D.
Shreveport, La.

**The Lymph Drainage from the Breast to the Axillary and Parasternal Lymph Nodes Studied with the Aid of Colloidal $Au^{198}$.** K. A. Hultborn, L.-G. Larsson, and I. Ragnhult. Acta radiol. **43:** 52–64, January 1955.

After a brief review of the contributions of others on the lymphatic drainage of the breast, the authors report their own study, in which they made use of radioactive gold. In a series of 40 patients with mammary cancer a tracer dose of 1 to 5 mc of $Au^{198}$, in the form of the red colloid, in a few cubic centimeters of fluid, was injected into the breast as far as possible from the primary tumor. Radical excision of the breast was done one to ten days later, with preoperative irradiation in most cases. After the operation, when the $Au^{198}$ depot was removed, *in vivo* measurements were made with a directional scintillation counter over the various node-bearing areas. The operative specimens were similarly investigated.

It was found that most of the colloid (over 85 per cent as a rule) remained at the site of injection, and only a small part was deposited in the node areas. In 14 cases in which both the axillary and parasternal nodes were studied, these were found to contain 0.1 to 11.0 per cent of the injected colloid. Of this amount, 90 to 97 per cent was in the axillary nodes.

In all 40 cases there was some axillary uptake of radiogold, though some normal nodes showed none and in others uptake was limited to a small part of the node. Cancerous parts of the nodes contained none of the isotope but it was present in small remnants of lymphatic tissue. In each of the 14 cases in which the parasternal nodes were examined some uptake was found.

The investigators conclude that lymph drainage occurs from all parts of the breast to both the axillary and parasternal nodes. Hence metastasis is possible, regardless of the site of the primary tumor. The great difference between the uptake in the axillary and the parasternal nodes indicates that only a small proportion of the lymph is transported from the breast by the parasternal route as compared with the axillary.

The authors feel that a radiocolloid with more rapid uptake in the nodes than radiogold, a suitable half-life, and a more energetic $\beta$ radiation might be a useful adjunct in the treatment of early parasternal metastases.

Twenty-five radioautographs; 1 photomicrograph; 15 drawings; 3 tables. JOHN F. BERRY, M.D.
University of Louisville

**Treatment of Papilloma of Bladder with Radioactive Colloidal Gold $Au^{198}$.** Frank Ellis and R. Oliver. Brit. M. J. **1**: 136–139, Jan. 15, 1955.

The authors describe a new technic of treating multiple villous papillomata of the urinary bladder, using the beta radiation of $Au^{198}$ instilled into the bladder *via* a urethral catheter. A calculated dose of 3,000 r (2,700 rep beta dose, 300 r gamma dose) is delivered to the bladder epithelium in several hours after instillation of approximately 300 mc of $Au^{198}$ in 100 ml. of saline. The colloid is not precipitated by the acid medium of the bladder urine, nor is there significant systemic absorption of the radioactive material. Serial washings of the bladder insured that less than 0.5 per cent of the original activity remained in the bladder.

Although the method is best suited for multiple papillomatous lesions, the authors have employed it in cases of mixed carcinoma and papillomatosis and in malignant tumors to reduce surface growth in preparation for other procedures. It was also used to abate hemorrhage from multiple small tumors in preparation for cystoscopy.

Each case must be individualized to integrate the procedure into the treatment program.

One should consult the original article for treatment routines, technics, and calculation of the delivered dose. A useful nomograph for calculating dosage is given.

Four figures. ALBERT R. BENNETT, M.D.
Mt. Sinai Hospital, Cleveland

**Distribution and Pathology Resulting from the Intracerebral and Intraventricular Injection of Radioactive Gold and Silver Coated Radiogold Colloids.** C. C. McClure, Jr., E. L. Carothers, and P. F. Hahn. Am. J. Roentgenol. **73**: 81–87, January 1955.

Small volumes of radioactive gold colloids of high specific activity were injected into the brains of a series of dogs and studies were performed to determine localization and effects of the injected material. Fifty-two animals were utilized in the study. Fifteen received purely intracerebral injections, 18 received intraventricular injections, and the remainder a mixture of the two. After different intervals, the brains were removed, fixed, and sectioned.

It was determined that the intracerebrally injected gold remained sharply localized within the brain tissue and exerted a demonstrable effect in only a relatively small zone. Gold injected into the lateral ventricle gained ready access to the entire ventricular system of the animal, as would be expected, but the radioactive material tended to localize in the posterior portions of the brain. A significant finding is that the choroid plexus of the lateral ventricle absorbed the radioactive material with high specificity and accounted for a large part of the injected dose. Histologic studies showed no striking morphologic changes in choroid structure despite concentration of the highly active material.

Control animals receiving injections of non-radioactive material showed only limited localized changes of a minor type.

Conclusions are that intracerebrally injected gold will remain sharply localized at the point of injection and is hence a potentially valuable agent in treatment of certain cranial neoplasms. Material injected into the ventricular system will be highly concentrated or absorbed by the choroid plexus. In view of the fact that roentgen radiation has been shown to decrease secretion of spinal fluid, a value of radioactive gold treatments in certain selected types of hydrocephalus is suggested.

Two graphs; 1 photograph. J. W. BARBER, M.D.
Cheyenne, Wyo.

**The Effects of Antitumor Drugs upon $P^{32}$ Incorporation into Nucleic Acids of Mouse Tumors.** Jack D. Davidson and Betty B. Freeman. Cancer Res. **15**: 31–37, January 1955.

Previous studies, for the most part, have indicated that effective antitumor compounds depress the incorporation of various nucleic acid precursors into desoxypentosenucleic acid (DNA) in treated animals. The authors present evidence to show that this is not a necessary accompaniment of antitumor activity. Radioactive phosphorus was chosen for the labeled precursor for the investigation. The tumor used was adenocarcinoma 755 in C57BL/6 mice. No primary effect upon the incorporation of $P^{32}$ of inorganic phosphate into tumor DNA was observed in the case of the alkylating agents, Myleran (1:4 dimethane sulfonoxybutane), nitrogen mustard, triethylene melamine, or triethylene phosphoramides, despite dose levels adequate to inhibit tumor growth. The purine analogs, 8-azaguanine and 6-mercaptopurine, caused depression of nucleic acid synthesis. This contrast suggests the existence of fundamentally different mechanisms of action for the two classes of compounds, with primary inhibition of nucleic acid synthesis applying only in the case of the purine antimetabolites.

Three tables.

**Uptake of Radioactive Iron ($^{59}Fe$) by Nucleated Red Cells *in Vitro*.** L. G. Lajtha and H. D. Suit. Brit. J. Haematol. **1**: 55–61, January 1955.

$Fe^{59}$ ($FeCl_3$) in a stock solution in 5 per cent globulin was added to cultures of cell suspensions from human bone marrow. Smears and autoradiographs were prepared to determine the red cell uptake of the radioactive iron.

Although hemoglobin synthesis and $Fe^{59}$ uptake are not necessarily identical processes, a rapid accumulation of iron was observed only in the nucleated red cells and reticulocytes, being maximal in the late pronormoblast and basophilic normoblast stages. The $Fe^{59}$ was localized in the cytoplasm.

X-radiation (300–5,000 r) of the cultures caused a shift of the differential count with a decrease in the number of the red cells which had a high percentage of $Fe^{59}$ uptake. The actual uptake of the $Fe^{59}$ in the surviving cells was unchanged, thus indicating that a shift in the differential count, rather than an inhibition of iron uptake, is the probable explanation for the previously reported radiosensitivity of iron uptake *in vivo*.

Six autoradiographs; 2 tables; 1 graph.
RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Anaemia and Erythropoiesis in the Irradiated Rat: An Experimental Study with Particular Reference to Techniques Involving Radioactive Iron.** C. F. Baxter, E. H. Belcher, Eileen B. Harriss, and L. F. Lamerton. Brit. J. Haematol. **1**: 86–103, January 1955.

Radiation anemia and recovery from it in young rats were studied by means of total-body x-irradiation and injection of $Fe^{59}$. The following observations were made:

Erythropoietic activity was measurably depressed

by 25 r given forty-eight hours prior to the injection of $Fe^{59}$.

Only large doses (400 r) caused a marked increase in fecal $Fe^{59}$ due to severe intestinal hemorrhage.

Recovery from anemia due to bleeding occurred immediately, with erythropoietic activity of spleen and bone marrow. Recovery from radiation anemia (450 r) commenced only after twenty days and was due mainly to spleen erythropoiesis.

Shielding one hind limb lessened the severity of the anemia and permitted a high degree of erythropoietic activity in that limb following irradiation. It also hastened return of spleen activity.

Splenectomy did not result in a more severe radiation anemia and hind-limb shielding was as effective in protecting these animals as those with intact spleens.

Thirty-one graphs; 2 tables; 2 charts.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Studies of Bone Metabolism. I. A Comparison of the Metabolism of Strontium$^{90}$ in Living and Dead Bone.** Robert D. Ray, Duane La Violette, Harold D. Buckley, and Roscoe S. Mosiman. J. Bone & Joint Surg. **37-A:** 143–155, January 1955.

Viability of bone cells is not essential in the process of inorganic salt uptake by bone, provided the organic matrix is present and normal. Mobilization of the inorganic salts from bone, on the other hand, is facilitated by the presence of living cells. As a result, the change in radiographic density in aseptic necrosis of bone is probably due to combined failure of mobilization of inorganic salts and continued uptake by the necrotic bone from the tissue fluids, in addition to the decrease in density of surrounding viable bone, *i.e.*, the increase in density of dead bone is actual as well as relative. Bone-seeking radioactive emitters, such as radium, probably become relatively fixed in the skeleton when radiation damage is sufficient to cause necrosis of bone cells.

These are the conclusions of the authors following a series of experiments utilizing adult rats. Several dozen animals were used and divided into approximately equal groups for *in vivo* and *in vitro* studies. In each instance determinations were made for uptake and mobilization of radioactive strontium both in viable bone (left radius) and in bone subjected to freezing in liquid carbon dioxide and later restored to position in the limb (right radius). Each animal in the "uptake" group of the *in vivo* study received a single injection of $Sr^{90}$ intraperitoneally twenty-four hours prior to autopsy. In the mobilization study the isotope was injected prior to the freezing of bone segments, this being the only difference in preparation of the animals in the two studies.

From histologic sections it was apparent that repeated freezing and thawing of bone was effective in producing aseptic necrosis. Devitalized bone showed approximately 70 per cent as much uptake of $Sr^{90}$ as did the control bone (left radius), with no apparent difference in the ratio one day after devitalization and thirty-one days later. Initially $Sr^{90}$ was mobilized more rapidly from viable than from devitalized radius, although an equilibrium was approached at thirty-one days.

Two parallel studies were carried out on tissue cultures in which surface areas exposed to bathing fluids would be the same. This was necessary because of the differences in circulation of living and dead bone caused by the circumstances of the first pair of experiments. There was no significant difference between the ability of dead and living bone to take up $Sr^{90}$ from the culture medium over exposure periods of two and nine days. There was a significantly more rapid rate of mobilization of $Sr^{90}$ from living bone maintained in tissue culture.

Four photomicrographs; 4 charts; 5 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

**The Use of the Isotope $^{51}Cr$ as a Label for Red Cells.** P. L. Mollison and N. Veall. Brit. J. Haematol. **1:** 62–74, January 1955.

Simultaneous experiments with $P^{32}$ and $Cr^{51}$-labeled red cells show that the determination of red cell volume by these methods agrees with slight variance.

The rate of disappearance of $Cr^{51}$-labeled red cells from the blood has two phases: an early rapid loss and a later slow loss. Experiments to determine the cause of this early loss and to prevent it were unsuccessful, but the rate of disappearance of the $Cr^{51}$-labeled cells was found to vary little from one normal subject to another, thus indicating its suitability for determining any abnormality in the rate of red cell elimination.

It is estimated that the tracer doses utilized resulted in about one-tenth of the maximum permissible daily dose of radiation.

Five graphs; 3 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

## RADIATION EFFECTS; PROTECTION

**Pathogenesis of Intestinal Ulcers Following Irradiation. Effects of Colostomy and Adhesions.** Nathan B. Friedman. Arch. Path. **59:** 2–4, January 1955.

Ulceration is a well known consequence of irradiation of the gastrointestinal tract. While most observers believe that the ulceration reflects the direct effect of ionizing radiation, others think that the ulcers are not produced by irradiation alone but by the impingement of the secondary factors on a surviving, albeit altered, mucous membrane. The author describes an attempt to duplicate the clinical situation in which a loop of bowel adherent to a cervical stump treated with radium or roentgen rays receives heavier irradiation than the remainder of the intestine.

In one experiment, using rabbits, a segment of the intestine was anchored to the abdominal wall and a total of 4,000 r was given in daily doses of 400 r. Control animals were irradiated without surgery. In a second experiment in rats, gold seeds containing 10 to 15 mc of radon were inserted through an anterior abdominal incision into the psoas muscle alongside the descending colon. One-third of the animals were subjected to colostomy at the time that irradiation was begun, one-third had had colostomy a week or two before, and one-third had no operation.

Doses of irradiation sufficient to produce intestinal ulcers failed to result in ulceration when the fecal stream was deflected by means of colostomy. Ulcers

did not always develop at points of maximal irradiation. The results of the study indicate that the diffuse intestinal injury produced by irradiation merely sets the stage for secondary damage and that fecal mechanical and bacterial action is probably responsible for ulceration. Irradiated mucosa cannot replace itself successfully or repair the minor injuries normally produced by the passage of feces. Irradiation ulcers, and possibly other ulcerative lesions of the gastrointestinal tract, result from the interaction of multiple factors, one of which appears to be passage of intestinal contents. No matter what mechanism inflicts the initial damage, it seems evident that whether or not ulceration occurs depends on secondary factors, in particular the effects of the movement of the fecal stream. The gastrointestinal tract, like other tissues and organs, reacts to injury in a pattern determined by its own structural and functional organization.

Five photomicrographs.

**Development of Endometrial Carcinoma Subsequent to Irradiation for Carcinoma of the Cervix.** Frederick P. Zuspan. Am. J. Obst. & Gynec. **69**: 59–63, January 1955.

A single case is presented in which endometrial carcinoma developed fourteen years subsequent to an unknown amount of intracavitary radium for carcinoma of the cervix classified as Stage I. Photomicrographs of the original squamous-cell carcinoma and the adenocarcinoma of the endometrium are presented. Numerous authors are quoted favoring irradiation as a factor in the pathogenesis of endometrial carcinoma.

One photograph; 2 photomicrographs.

R. L. EGAN, M.D.
M. D. Anderson Hospital, Houston

**The Effect of a Single Dose of X-Rays on the Peripheral Blood Count of Man.** W. M. Court Brown and John D. Abbatt. Brit. J. Haematol. **1**: 75–85, January 1955.

Single x-ray exposures over the spine and sacroiliac areas were given to 16 patients suffering from ankylosing spondylitis. The areas irradiated ranged from 465 to 750 sq. cm., and the surface dose (with backscatter) from 200 to 425 r (250 kv, h.v.l. 1.6 to 1.9 mm. Cu, 45–50 r/min.). It is estimated that the bone marrow of the spinal column received 135 to 285 r.

The first phase of hematological response was a rise in neutrophil count, which developed in several hours, in some instances before symptoms of radiation sickness appeared. The lymphocyte count began to fall in twenty-four hours and the downward trend continued for several days. The total white cell count fell after the second day and the neutrophil count after the sixth day. Platelet counts remained unchanged over the five days in which it was studied.

Serial venous hematocrits of 7 out of 11 patients studied showed a significant fall within the first three days. This was postulated to have been the result of an increase in plasma volume, possibly due to disturbed intracellular-extracellular fluid balance. Although, strictly speaking, the subjects in this investigation were not normal, it can be assumed that qualitatively similar changes will occur in normal human beings exposed to large doses of whole-body irradiation.

Sixteen graphs; 2 tables.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**A Comparison of the Effects of Radiation and Radiomimetic Chemicals on the Blood.** L. A. Elson. Brit. J. Haematol. **1**: 104–116, January 1955.

The effect of whole-body x-irradiation on the body weight and blood of rats was compared with the response to Myleran (1:4 dimethane sulfonoxybutane) and the "nitrogen mustard" derivative CB 1348. A combination of the myeloid depressant effect of Myleran and the lymphoid depressant effect of CB 1348, when they were given in equal amounts, produced weight and blood effects similar to a single dose of whole-body x-irradiation.

Eighteen graphs; 1 table.

RICHARD E. BUENGER, M.D.
Chicago, Ill.

**Effect of Whole-body X-Irradiation on Lipids in the Liver, Kidney, and Spleen of Fasted Rats.** W. E. Cornatzer, J. P. Davison, O. D. Engelstad, and Carol Simonson. Radiation Res. **1**: 546–550, December 1954.

The authors describe an investigation of the effects of whole-body irradiation (700 r or 1,120 r) on phospholipid synthesis in tissue slices of rat liver, spleen, and kidney and the lipid distribution in the whole organs. It was found that irradiation caused little change in the incorporation of $P^{32}$ in the phospholipids of the liver and kidney; however, a slight inhibition was observed in the tissue slices of the spleen. There was no difference in phospholipid synthesis in liver slices of fasted and non-fasted animals. No significant changes were observed in phospholipid phosphorus in the kidney, or in the concentration of cholesterol in the spleen, liver, and kidney, due to irradiation.

**Histochemical Studies of the Effect of Irradiation of the Placenta.** Alvan G. Foraker, Sam Wesley Denham, and Dorothy D. Mitchell. Arch. Path. **59**: 82–89, January 1955.

A single dose of 1,200 r (200 kvp) was given over the left uterine horns of 12 rabbits on the ninth day of gestation. Five days later the animals were killed and the placental tissue from the right and left uterine horns was studied. Tissue from the right uterine horn showed no evidence of radiation damage. In tissue from the left horn, evidence of damage was concentrated in a proportion of syncytial cells and in decidual cells in perisyncytial loci. These manifested degeneration, nuclear pyknosis, disintegration, and cell necrosis. Cytochemically this cellular damage was reflected by diminution in evidence of dehydrogenase activity, appearance of lipid-staining propensities more marked than in control material, granular alkaline phosphatase staining, and non-glycogen type reaction to the periodic acid technic. The decidual cells also showed diminution in glycogen type staining. These reactions appear to be non-specific manifestations of cellular damage, not peculiar to radiation effect. The cytochemical evidence of radiation damage corresponded in distribution to the cytomorphological manifestation of this reaction.

Twelve photomicrographs.

**Effect of High-Intensity X-Radiation on Velocity of Nerve Conduction.** Herbert B. Gerstner, John S. Orth, and Everett O. Richey. Am. J. Physiol. **180**: 232–236, January 1955.

Sciatic nerves of bullfrogs and rabbits were isolated

and stored at 24° C. Conduction velocity was determined prior to and at one, two, and four hours following exposure to various doses of x-radiation, delivered at a rate of approximately 9,000 r per minute. The irradiated nerves, compared with those which were not irradiated, showed the following results: (1) In frog nerves, doses in excess of 75,000 r caused a decrease in conduction velocity; doses above 300,000 r produced complete abolishment of nerve conduction within one hour following irradiation. (2) Rabbit nerves proved to be much more radiosensitive than frog nerves; doses in excess of 45,000 r produced complete block within one hour following irradiation.

Four illustrations; 2 tables.

**Biological Modification of Effects of Roentgen Rays. I. Reduced Temperature.** Frederick M. Allen. Am. J. Roentgenol. **73**: 70–80, January 1955.

LD-50 and LD-100 doses of total-body irradiation were determined for healthy adult rats. Small groups of comparable animals were then exposed to controlled doses of total-body irradiation under various imposed laboratory conditions, and the effect on their survival was studied. Animals whose body temperatures were reduced considerably below normal by total-body chilling showed a definitely increased resistance to radiation as manifested by their survival following exposure to higher doses of total-body irradiation. Severe asphyxia uniformly elevated the survival rate. Severe starvation or production of artificial fever both produced a decrease in resistance to radiation effects.

Additional studies were then performed in which only parts of the animals were placed under experimental conditions before irradiation, followed by exposure of the part only. Refrigeration of extremities, starvation, asphyxia of an extremity, or heating produced results which were not nearly so conclusive as those obtained with whole-body studies. The effects tended to be in the same direction, however, as those demonstrated in the whole-body studies.

Other results indicate that the same experimental conditions imposed *after* irradiation will have little or no effect on the tolerance of the extremity. The only exception appears to be somewhat less severe superficial effects on extremities which are chilled for prolonged periods beginning immediately after administration of radiation. These studies fail to show any consistent effect on the curability of rat sarcomas.

One table.

J. W. BARBER, M.D.
Cheyenne, Wyo.

**Studies on the Nature of Immunity to *Trichinella spiralis* in Parabiotic Rats. VII. The Immune Response of the "Uninfected" Twin One Month after Its Mate Received an Immunizing Dose of Irradiated (X Ray) Larvae.** Herman Zaiman, James M. Stoney, June Rubel, and Norman C. Headley. Am. J. Hygiene **61**: 5–14, January 1955.

Investigations previously described showed that when one member of a pair of parabiotic rats is infected with an appropriate number of *Trichinella spiralis* larvae, its mate usually becomes more resistant to infection with that parasite than are control rats. It has also been demonstrated that x-rays may reproductively sterilize *Trichinella* and further that such sterilized larvae may elicit an immune response from single rats and mice. The authors report the results in two experiments designed to determine whether infection with such sterilized worms could immunize a parabiotic rat and initiate a similar response in its "uninfected" mate.

It was found that infection of one member of a pair of parabiotic rats with a single dose of *Trichinella spiralis* irradiated with 10,710, 12,750, 11,730, or 13,770 r was adequate to make that rat resistant to infection with non-irradiated larvae one month later. It was further shown that, when one such twin was infected with irradiated larvae, its "uninfected" mate became more resistant to infection with that parasite than were rats in control pairs. The strength of the resistance in the infected rat was greater than that shown by the "uninfected" twin.

Two tables.

**Pathology of Swine Exposed to Total Body Gamma Radiation from an Atomic Bomb Source.** John L. Tullis, Baldwin G. Lamson, and Sidney C. Madden. Am. J. Path. **31**: 41–71, January–February 1955.

A study was made of the appearance and progression of lesions produced in swine by 700 gamma roentgens total-body irradiation. The source was an atomic bomb and the only shield was aluminum, used to protect the animals from thermal and mechanical injury. This order of radiation was 100 per cent lethal in eight or nine days.

The earliest lesions, seen in four hours, were lymphoid cell necrosis and arrest of mitotic activity with only minimal regeneration occurring before death. Diminution of hematopoietic activity began within eight hours of exposure and continued steadily up to death.

In the alimentary tract the earliest change, occurring within four hours, was epithelial necrosis in the deep glands of the small bowel. This was associated with lymphoid depletion in the lamina propria, in the same degree as in lymphoid tissue elsewhere.

The late stage of this acute injury was characterized by widespread hemorrhage into the tissues and into the lumina of the hollow viscera. This was accompanied by terminal invasion and growth of bacteria.

Twenty-two photomicrographs; 10 photographs; 3 tables.

RICHARD E. OTTOMAN, M.D.
University of California, L. A.

**Effects of Somatotropic Hormone (STH) and Saline on Mice Exposed to Total-Body Irradiation.** Mitchell W. Spellman, Franklin E. Roth, Leo Blank, and C. Walton Lillehei. Cancer **8**: 172–178, January-February 1955.

This study represents an attempt to evaluate the effects of pituitary growth hormone (STH) and saline on morbidity and mortality in mice after lethal doses of total-body irradiation. It appears from these studies that irradiated mice have a diminished tolerance to the daily subcutaneous injection of 0.2 or 0.5 c.c. of saline, as demonstrated by the more rapid rate at which the animals succumbed. The thirty-day mortality in mice exposed to 550 r was increased to 75 and 85 per cent respectively, as compared to 70 per cent in irradiated but untreated controls, but these increases are not significant statistically. The daily subcutaneous administration of pituitary growth hormone in small dosage (0.1 mg. per day) effectively neutralized the increased mortality observed in irradiated mice receiving either 0.5 or 0.2 c.c. of saline per day. Larger doses of the hormone were ineffective in this respect and actually enhanced the thirty-day post-irradiation mortality.

The subcutaneous administration of the somato-

tropic (pituitary growth) hormone in 0.1-mg. doses in either 0.5 or 0.2 c.c. saline per day for two weeks prior to exposure to irradiation further decreased the thirty-day post-irradiation mortality to levels significantly lower than were observed in either the saline-treated or untreated irradiated controls.

The increased resistance to radiation injury attributed to pretreatment with small doses of the hormone was not reflected by greater weight increases or smaller weight losses.

On the assumption that the observed beneficial effects of small doses of somatotropic hormone upon post-irradiation mortality in mice are based upon its anabolic properties, the authors suggest a mechanism whereby the consequent diminished tissue destruction and nitrogen excretion facilitate conservation of vital electrolytes.

Five photographs; 1 table.

THEODORE E. KEATS, M.D.
University of California, S. F.

**Practical Control Measures for Employees Exposed to Ionizing Radiation Hazards. Medical Control.** Bernard R. Nebel. South. M. J. **47:** 1147–1148, December 1954.

The author discusses briefly the treatment of the person who has inhaled or swallowed radioactive material. In the first event, a very significant fraction of the material is entrapped in the hairs of the vestibular space of the nares and the flagellate and mucus-covered surfaces of the turbinates and the posterior or inner nares. Simple clipping and removal of the hair in the nasal vestibule, blowing by the patient, and inhaling by mouth and exhaling vigorously through the nose (as in swimming), will remove much of the contaminant. Washing is accomplished by having the patient snuff water into the nasal passage and forcefully expel it by blowing through the external nares. Rinsing should be done with a nasal applicator and saline under gravity, the patient being instructed under no circumstances to swallow the irrigating solution. Induced vomiting may be considered, inasmuch as the concomitant coughing and reverse peristalsis clear at least parts of the upper gastrointestinal tract and parts of the middle and lower respiratory tract.

In the patient who has swallowed radioactive material, vomiting should be induced. Hypertonic salt solution, one glass immediately, is excellent for this purpose. Ipecac and milk may follow the saline. Milk proteins and fat will bind certain chemicals which would otherwise adhere to the stomach wall. Proper positioning of the patient for vomiting is necessary to avoid aspiration. It is extremely important to know the nature of the ingested material to make the treatment effective. Laxatives and forced fluids should not be ordered indiscriminately.

**Observations on the Use of Chlorpromazine Hydrochloride in Radiation Sickness.** D. O'Connell. J. Fac. Radiologists **6:** 214–216, January 1955.

Chlorpromazine hydrochloride, a phenothiazine derivative, has a marked antiemetic action, especially when the emesis is centrally induced. It was used in the Radiotherapy Department at Charing Cross Hospital (London) in 38 patients receiving irradiation for various conditions. Results were good in 20 patients and fair in 15; 5 patients derived no benefit from the medication. The dosage used was 25 mg. (occasionally 50 or 75 mg.) by mouth three times a day. In cases of intractable vomiting the drug was given intramuscularly for the first few doses. Side-effects were mainly drowsiness and acute depression, and in 2 instances the drug was probably responsible for subacute toxic hepatitis.

The drug was generally found to cut short severe nausea and vomiting from radiation sickness, in some cases relieving them completely and in the majority to a sufficient degree that irradiation could be carried out as planned. Usually on withdrawal of the drug during the course of irradiation the symptoms reappeared, though sometimes the patient did not need further medication after the first week of treatment. Diarrhea did not respond to chlorpromazine, though whenever this symptom was combined with nausea and vomiting the latter were usually completely relieved. However, patients who were receiving the drug for nausea before the onset of diarrhea did not seem to suffer the effects to the same degree as those who were treated after diarrhea had become established. Results obtained were not dependent entirely upon the trunk volume being irradiated, since in some of the "good" cases large integral doses were being given.

[Chlorpromazine has been introduced into the United States under the trade name Thorazine. That its use is not without risk is indicated by a report by Gold, Rosenberg, and Campbell (Ann. Int. Med. **43:** 745, 1955), describing 3 cases of hepatitis following its administration in cases unassociated with irradiation. Because of the serious nature of this hepatic reaction, these authors warn against indiscriminate use of the drug.—Ed.]

**Control of Radiation Hemorrhage with Splenic Extracts.** J. Philip Savitsky. Blood **10:** 52–61, January 1955.

This article describes the finding in animal tissues of a clot retraction accelerator which could neutralize *in vitro* and *in vivo* the plasma clot retraction time inhibitor present in irradiated dogs. This substance is capable of modifying the hemorrhage following whole-body irradiation. Almost total prevention of the hemorrhagic symptoms, however, had no effect in prolonging survival of the irradiated animals, which suggests that the hemorrhage probably plays no role in the ultimate mortality of the animals.

The author concludes from his experiments that there is a substance present in all mammalian tissues which accelerates the initiation of clot retraction. This substance is present in highest concentration in the spleen. A crude protein extract of beef spleen containing this tissue clot retraction accelerator injected into irradiated dogs can prevent the hemorrhagic syndrome. Further purification of this factor has indicated that it is only partly responsible for the control of the clotting defect and that other substances are necessary.

Four graphs; 4 tables.

THEODORE E. KEATS, M.D.
University of California, S. F.

**The Law Relating to Work at X-Ray Installations in Hungary.** Josef Slanina. Acta radiol. & cancerol. bohemoslov. **8:** 184, July 1954. (In Czechoslovakian)

The provisions of the new Hungarian law regarding the working conditions, vacations, compensation, and retirement (pensioning) of x-ray workers are more liberal than in other types of employment. There is "additional risk pay" (amounting up to 30 per cent of

the base pay); the annual vacation time is fourteen days longer than in "non-risk" occupations; the daily working time is shortened to six hours, and retirement with pension is possible five years earlier than in other employment (minimum fifty-five years for men and fifty years for women). Strict measures for the health protection of the workers by control and supervision of the x-ray installations and by semiannual medical examination (including hematologic and dermatologic examinations, roentgenograms, etc.) are provided.

E. A. SCHMIDT, M.D.
Hilo, Hawaii

**Radon Released from Concrete in Radiant Heating.** A. F. Gabrysh and F. J. Davis. Nucleonics **13:** 50, January 1955.

Concrete mixtures often contain rock in which uranium and radium ore may be present. Specimens of concrete were sealed inside a glass tube and the accumulation of liberated radon was measured with an ionization chamber. Heating the specimens increased the diffusion of the gas through microfissures. It is concluded that building materials having an average uranium concentration of 0.004 per cent and higher produce sufficient radon gas at ordinary room temperatures to be unsafe.

One figure; 1 table.

JOHN S. LAUGHLIN, Ph.D.
Memorial Center, New York

**Marble as a Radiation Shield.** Marshall Brucer. Nucleonics **13:** 65–66, January 1955.

Data on fourteen different kinds of marble indicate uniformity of density and absorption properties for gamma rays and x-rays. The absorption and half-value layers of marble for various qualities of radiation from 75-kv up to 1.25-mev gamma rays are tabulated and compared with figures for lead and concrete. The half-value layers of a large number of common materials are presented in a figure and in a table for various energies of gamma rays.

For gamma-ray shielding of rooms where appearance and cleanliness are factors, the use of marble is economical and deserves serious consideration. In some applications, marble bricks are more durable than lead bricks.

One figure; 3 tables.

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